POWER

A McGRAW-HILL PUBLICATION—ESTABLISHED 1884

ELY C. HUTCHINSON, *Editor*

Volume 74 NEW YORK, AUGUST 11, 1931 *Number 6*

Shopping

IN ASIA they have the old practice of trade and barter. The purchaser never pays the price originally quoted by the seller. Buying and selling is there a game of wits. Often the shrewdest is fooled by a spurious product. When such is the case he tries to recuperate by passing the merchandise on to another.

In America we have raised buying to a higher plane. The seller is a person or firm of integrity. The price asked for the product has been carefully set to meet the cost of production and selling and leave a margin of profit upon which it is worth while for the firm to continue to do business.

The purchaser is entitled to the greatest value obtainable for the money expended. He has the privilege of asking several concerns manufacturing or selling a similar product to quote. These concerns, realizing that the bid is competitive, submit their best price consistent with good material and workmanship.

If the purchasing agent, thinking to better the price obtained on the open competitive bid, plays one bidder against the others he will invariably get a lower price than any originally quoted. This is known to the trade as "shopping." The agent is able to show a paper saving for the Purchasing Department. If the bargain is bad he passes it, in the manner of our brother of the Far East, on to the Maintenance Department.

What is the effect upon the one who obtains such an order? I have recently heard of a contractor who was so blessed. "Well" he said,"I can use such and such materials. They are not so good by one-third as the materials I had planned on using. We will have John Doe do the work. He is not reliable but his price is away below anybody else's and we can get by if we watch him."

"What about your reputation for quality?"

"Quality, hell! It will last a year, which is all that I have to guarantee it for. Even if it don't I will have made enough so that I can afford to keep it going that long. And after that some of us will have another job. Fair play? Sure it is. The buyer showed me a new set of rules for this game and if it's the set he wants to play with—suits me."

Yes. We get what we pay for.

EDITORIALS

A Significant Step In Diesel Development

VERNON, a thriving California industrial city adjoining, but unabsorbed by, Los Angeles, has arranged for its future electric power needs by purchasing five diesel engines of six thousand kilowatts' capacity each. Aside from the fact that this single installation of approximately forty thousand horsepower will be the largest, both in capacity and size of engine, in America, it has a number of other interesting aspects.

There are many places where diesel engines can be used to economic advantage in this country, but a peculiar combination of circumstances has retarded their acceptance beyond any reason warranted by their economic and technical suitability.

Meanwhile the European electric power companies have been quick to take advantage of the availability of diesel engines in the large sizes, either *in toto* or in combination with other power units for peak- or base-load service.

Some of the largest diesel developments for this class of work have been in Germany. Only three years ago the fifteen-thousand-horsepower Hamburg installation was outstanding. This was rapidly followed by the Hennigsdorf substation, where two eleven-thousand-seven-hundred-horsepower engines were installed. Just recently an order for two twelve-thousand-horsepower, two-stroke-cycle, double-acting engines was placed in Switzerland for the new peak-service and reserve plant of St. Gallen. Another order of the same kind is expected to be placed shortly for the Swiss State Railways as a reserve installation for hydro power plants at Rupperswil.

In addition, the City of Fribourg, Switzerland, has purchased an eleven-thousand-horsepower engine with eight twenty-eight-inch by forty-eight-inch cylinders operating at one hundred and fifty revolutions per minute.

The Municipal Electricity Works of Copenhagen has recently purchased from a well-known local builder an eight-cylinder diesel engine with a five-foot stroke at one hundred and seven revolutions. Its capacity is eighteen thousand horsepower normal and twenty-two thousand five hundred peak-service maximum.

These are a few of the cases which point to the growing regard for diesel engines in the field of electric power generation abroad. Moreover, the size to which the oil engine has successfully attained in Europe leaves American practice far to the rear.

For this there are but two basic reasons: the incentive for their manufacture and their appreciation by the purchaser. It is hard to say which will, or should, come first. And, in fact, there is plenty of room for enlightenment at both ends. If, then, the Vernon contract furnishes the stimulus, it may mark the beginning of the better understanding of diesel possibilities so lacking in this country.

Will They Go Back To Teaching?

THE "PROFS" took a lacing last week from an erstwhile academic boss, Dr. Clarence Cook Little, former president of the University of Michigan. He was talking to summer students at Columbia University.

"Some of the most distinguished loafing in America is being done by the faculty members of great universities . . . There seems to be no way of waking these gentlemen up because their appointment runs on and on and there is no alarm clock . . . the birth of a progressive forward-looking movement in American education from a faculty meeting I have yet to find . . . I have seen the best brains of a university spend two and one-half hours discussing why a system of electric clocks should be installed in the university buildings, during which period I have seen the subject of clocks change to dogs on the campus, to Greek art and to history or religion." With such stinging phrases as these did Dr. Little flay the dignified members of college faculties throughout the land.

He spoke also of research versus teaching and of the common emphasis on the former to the detriment of the latter. "The liberal arts college faculty member," he said, "is promoted on his lack of interest in teaching and on his attention to research. This is true of every

large university in America. I have seen scores of recommendations for promotion based upon research, and none based purely upon teaching ability."

Allowing for an apparent over-emphasis arising from unpleasant administrative experiences, is there not clearly a grain of truth in Dr. Little's blanket criticisms? Undoubtedly many men are so constituted temperamentally that the achievement of permanent tenure of office with the title of professor is accepted as the entrance to a period of glorified and dignified idleness. On the other hand, one must admit that it works the other way with genuinely creative personalities, their freedom generating new interest and new zeal.

Probably the most important matter touched upon by Dr. Little is that of research versus teaching. It would seem axiomatic that if a man is to teach he should know how. Yet all over the country men are teaching who lack the ability or the interest to produce a creative impulse in the student.

Research is of tremendous importance, but it seems illogical to reward achievements in this line by giving the achiever license to waste the time and interest of students. Some other way should be found to promote academic research.

Altogether too little attention is given to the science and art of teaching. Prospective college teachers study their specialties for years but generally never receive any specific instruction in the art of teaching.

Dr. Little was speaking primarily of professors in liberal art colleges. The conditions he criticizes are found much less frequently in engineering schools. The average engineering teacher takes his contacts with students at least as seriously as his experimental work. He makes a real—even if sometimes uninspired—effort to convey information and create interest. He recognizes the existence of teaching problems by attending such conferences as that held at Purdue two years ago.

The university teacher is faced with the same problem as the salesman and the public speaker. His erudition is useless if he fails, through lack of interest or of *know how*, to "put it over."

California Utility Aids Dairy Business

AN INTERESTING ATTITUDE, on the part of a public utility toward the economic difficulties of one of its customer-groups, appears in a recent news item.

A statement issued by the California Railroad Commission reports the California-Oregon Power Company as making a voluntary ten per cent reduction in its electric rates applying to the irrigation districts in Siskiyou County, California. This reduction is temporary and plans to alleviate the effects of a long-depressed market on the dairy business of these districts by assuming a share of the season's losses. The reduction is to remain for the rest of the season or as long as the price of butter fat remains below thirty-five cents a pound.

The extent of the reduction was determined by a joint study made by representatives of the irrigation districts, the division manager of the power company and an engineer of the railroad commission. It appears satisfactory to all concerned.

The reduction is evidently an attempt to bring the price of power nearer its proportionate place in the total production cost.

Of the three principal items—material, labor and power—which go to make the cost of production, the first two are quick to reflect the law of supply and demand. Power, however, has not responded in the same sense, since it has necessarily been furnished in accordance with fixed schedules.

Public utilities, of course, cannot vary their rates to hold power cost to a definite proportion of total cost even for one particular industry among their customers. Electric rates are rightly designed to provide a fair return to the utility stockholders.

In a case such as this, however, heavy and continued losses have threatened a serious curtailment of creamery activities in the district. These react not only on the farmer who sells milk and the workmen, both on the farm and in the creamery, but also on the stores, banks and other businesses relying partly on the dairies for their prosperity. The various business activities of any community are interrelated. A serious economic unbalance in one affects all—and they are all customers of the power company.

Thus the utility may well justify a temporary rate reduction even if it considers the situation solely from the viewpoint of the effect on its own business.

"Tempering the wind to the shorn dairyman" is good business when it keeps him and his neighbors active as buyers of electric energy. The California-Oregon Power Company is to be congratulated on its foresight and courage in applying a modifier to an otherwise serious economic difficulty in one of its customer-groups. It is hoped the experiment will be successful, since it contains the germ of an idea and utilities will watch it closely.

▼

POWER Stands for . .

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

▼

AT THOMAS A. EDISON PLANT

Departments Pay Cash For Steam and Electricity

Industries of Thomas A. Edison, Inc., Orange, N. J., are required to pay by inter-departmental check for power services delivered to them by the Plant Service Division. All services delivered are metered. Meters are checked yearly by an outside testing laboratory

ANY POWER PLANT associated with Thomas A. Edison would be of general interest, because of Edison's pioneer contributions to the development of power production and distribution. Yet the *Power* editor who recently visited the Thomas A. Edison industries in West Orange, N. J., was interested in the power plant not so much for reasons of history or sentiment as for the excellent example it furnished of good practice in computing the cost of steam and electricity, and of billing the using departments individually for their consumption.

The Thomas A. Edison industries are a closely knit group of completely independent units. In the group is the "Plant Service Division," which, for all practical purposes, might be separated and become an outside source of power and steam supply.

By this is meant that this division stands on its own in every particular. All expense, of whatever nature—for supplies, fuel, labor and the various small items entering the costs of production—are paid for by this division. Its products of every kind are metered and sold to the various consuming divisions.

Each source of supply and sales outlet is closely metered, and the unit costs are broken down into their essential factors, with close tabulation of monthly results to form a basis of comparison.

Several daily log sheets for power and steam are kept. From this information the daily operating costs are figured and consolidated into a accumulative account terminating monthly. At the end of the month all meters are read, the coal inventory is checked by measurements and the sales prices are determined from the results.

For the past five years these records of costs have shown a remarkable steady decline when volume of product is considered. Small things, apparently of little significance, have been checked and altered to produce a profit. The units in West Orange, N. J. where the storage battery division, general division, manufacturing division and several small divisions are situated, constitute the main plant. The official laboratory and shops of Mr. Edison comprise a separate group in West Orange.

The power plant for this group consists of six 6,000-sq.ft. horizontal water-tube boilers. Two, equipped with 125-deg. superheaters, and operating at 200 lb. pressure, serve a 2,500-kva. turbine, which (with its condenser) forms a "closed circuit" with no steam extraction.

The remaining four boilers are for the production of process and heating steam and are operated at 160-lb. pressure without superheaters. This entire installation is of the type which was considered up to date ten years ago. Two of the process boilers were installed in 1917.

By the aid of registering gages on all important operations, the Plant Service Division has established a standard of operation which cannot be deviated from in the smallest degree without attracting instant attention. Where needed, corrective measures are applied without delay. The men know that no excuse will be considered for failure to maintain cost standards.

The boilers at the Orange plant are equipped with economizers and are served by underfeed stokers with forced draft. The second plant under the jurisdiction of this department, located at Silver Lake, Bloomfield, N. J., consists of four 4,500-sq.-ft. horizontal water-

STEAM—UNIT COST PER 1,000 LB.

(Orange—1929)

Year 1929	January	February	March
Cost to Make:			
Labor	0.0390	0.0416	0.0525
Coal	0.2646	0.2642	0.2537
Coal shortage	.....	.....	.....
Water	0.0142	0.0112	0.0124
Current	0.0154	0.0155	0.0153
Expenses	0.0026	0.0009	0.0022
Auxiliaries	0.0217	0.0215	0.0236
Unit cost—total	0.3575	0.3549	0.3597
Expenses include taxes, rent, supervision, etc.			
Coal charged into cost, net ton	5.00	5.00	4.95
Lb. coal to 1,000 lb. steam	106	106	106
Steam Production (pounds):			
Auxiliaries	2,054,000	1,935,000	1,624,300
Steam sold	33,862,200	21,991,700	24,716,100

POWER—UNIT COST PER KW.-HR.

(Orange—1929)

Year 1929	January	February	March
Direct Charges:			
Labor	0.0016	0.0014	0.0014
Steam	0.0045	0.0050	0.0052
Current purchased	0.0053	0.0042	0.0040
Water	0.0002	0.0002	0.0002
Expenses	0.0013	0.0013	0.0010
Total	0.0129	0.0121	0.0118
Fixed Charges:			
Steam plant	.....	.....	.....
Reserve for maintenance	0.0013	0.0012	0.0012
Depreciation of bldgs	0.0004	0.0004	0.0004
Depreciation of equipment	0.0042	0.0042	0.0041
Total	0.0059	0.0058	0.0057
Total unit cost	0.0188	0.0179	0.0175
Costs include 15 per cent conversion and line losses.			
	Kw.-Hr.	Kw.-Hr.	Kw.-Hr.
Monthly production	908,567	924,361	941,558

tube boilers equipped with overfeed stokers and using individual steel stacks and natural draft.

With both forced- and natural-draft plants operating under identical metering conditions and served by the same grades of coal, the Plant Service Division has had an unusual opportunity to determine the ultimate dollar value of equipment of this class in the production of steam.

The boilers at Silver Lake are very much older than those at Orange, but are maintained in excellent condition at all times. Commenting on this, a representative of the Plant Service Division said, "For comparative cost purposes it is interesting to compare the cost of process steam produced by this distinctly 'old type' natural-draft plant with that produced by the more modern forced-draft installation. Considering original outlay of capital and the reduced maintenance of auxiliary firing apparatus in the old plant as against the more efficient but costlier maintenance of the more modern plant, the possible sales price of the process steam is identical in both plants."

The accompanying cost summaries show the net results of careful recording. In the final analysis, the actual consumption of coal and labor, etc., against pounds of steam produced is the essential business factor in any plant trying to determine real costs.

Coal consumption is not based on larry weights to the boilers from the stock pile, but rather on the larry weights plus a 3 per cent shortage factor. This factor is applied to all larry weights to compensate for losses of coal weighed at the mine, on which terms final coal figures must be based.

By this means calculations of costs are reduced to the absolute purchased weight of coal at mines and the steam sold by meter.

The electrical-induction type of steam flow meter is used on all out-going lines, as well as for the internal distribution of steam in the plant for all purposes. These meters give an accuracy within 1 per cent and have proved very reliable and efficient if handled properly.

Water is metered in two ways. The gross quantity received in the plant is measured by the regular form of meter and by venturi meters on boiler feed lines.

Coal is weighed in by traveling weigh larry from overhead bunkers.

Frequent coal tests are conducted on various coals to determine their actual dollar value to the plant. These tests are never of short duration, and are never especially prepared, for what is wanted is the demonstrated value of this tested coal under normal operating conditions. By closely checking operations at all times this becomes the equivalent of a "test run." A sample of every car of coal unloaded is accumulated into a combined sample of ten cars from a common source, and this sample is analyzed in the power plant laboratory. This procedure, well known to the plant's coal supply people, prevents carelessness as to grade.

All water used from any source is analyzed once a week to detect harmful ingredients that would affect maintenance.

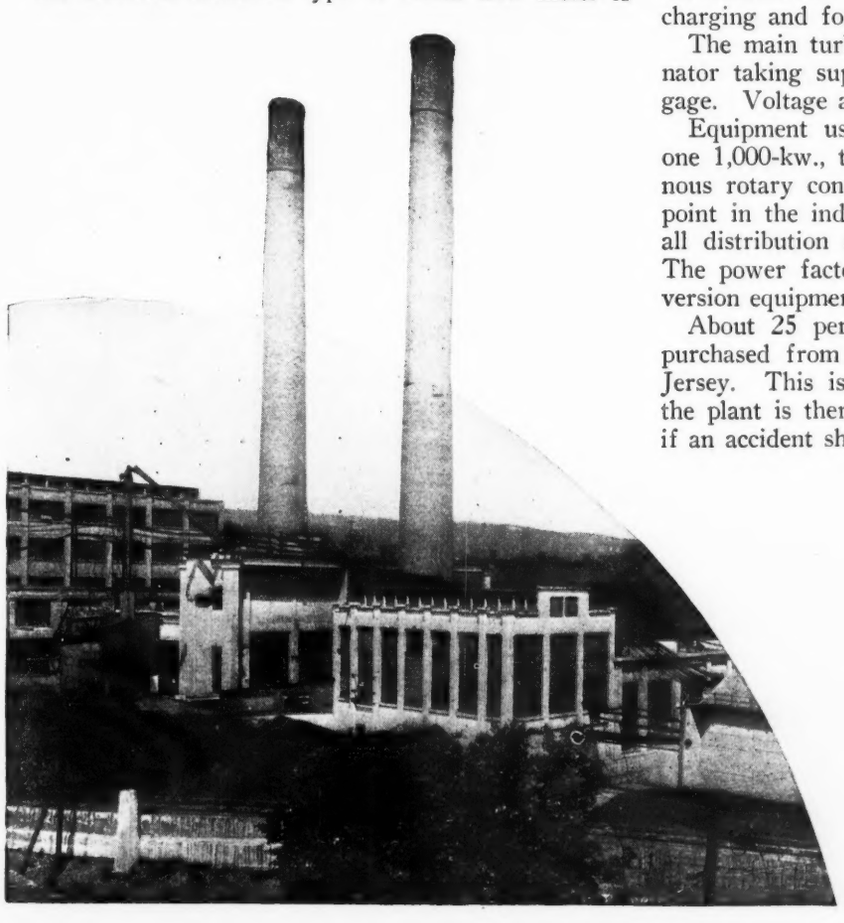
Care is taken that the fusing temperature of the ash is not too low for the furnace temperatures maintained. This seeming unimportant item had cost as much as $1,000 monthly in furnace lining and stoker repairs. By checking fusion temperatures this expense is positively eliminated.

In the production of power the Orange plant has a condition which few producers face. Alternating current is generated at 2,300 volts and converted into 100-220 direct-current power for use throughout the divisions. The reason for this peculiar arrangement is the demand for direct-current power for storage-battery charging and for plating operations.

The main turbine is a 2,500-kva., 3,600-r.p.m. alternator taking superheated steam (125 deg.) at 200 lb. gage. Voltage at the switchboard is 2,300.

Equipment used for conversion purposes comprises one 1,000-kw., two 500-kw. and two 200-kw. synchronous rotary converters, which are located at a central point in the industries in a separate substation, where all distribution and metering of power is centralized. The power factor is very high with this type of conversion equipment. It seldom falls below 99 per cent.

About 25 per cent of the power requirements are purchased from the Public Service Company of New Jersey. This is found to be a distinct advantage, as the plant is thereby assured of continuity of operation if an accident should disable the main unit.



In charging departments the practice at the Thomas A. Edison power plant is unusual in several respects. First, the meters are checked and certified each year by an outside testing laboratory, thus eliminating all dispute as to their correctness. Secondly, the consuming departments pay for their requirements by inter-departmental checks. Finally, every conceivable item of cost is charged against the Plant Service Division, so that a true value of what constitutes "power house" expenditure may be applied to the various products of manufacturing departments.

CORROSION TESTER

Compares Metals and Liquids

CORROSION is a primary problem in the design of power equipment and in its operation. Designers and operators will therefore be interested in a new simple and rapid method of making corrosion tests under actual service conditions. The corrosion tester shown was developed by Cloyd M. Chapman, consulting engineer, 105 West 40th St., New York.

With this equipment permanently attached to a boiler drum or other pressure vessel, samples may be introduced or removed while the vessel is under pressure. The method of operation will be clear from the cross-sectional sketch. After the specimen has been partly withdrawn, the gate valve is closed before the specimen is removed.

Two types of specimens are suggested for use with this tester: first, a very fine wire wrapped on a special notched porcelain spool, and, second, a small cube having one or more polished surfaces. Both forms of specimens are shown in the drawing and the photograph. The wires shown in the photograph are, however, larger than would be used in actual work.

The wire specimens are particularly designed for testing the relative corrosiveness of fluids in plants where weighing or photographic apparatus is not available. There is sufficient space on the spool to wind four wires, so that different grades of ferrous or non-ferrous metals may be tested at one time.

At the end of the predetermined periods of tests the specimen is removed and the wires inspected. If the wire breaks with a slight twist it indicates that the corrosion has proceeded to a depth of about one-half the diameter. The latter is usually about 0.003 of an inch.

Where apparatus for micro-photography is available, the use of the polished cube is preferred. With it very

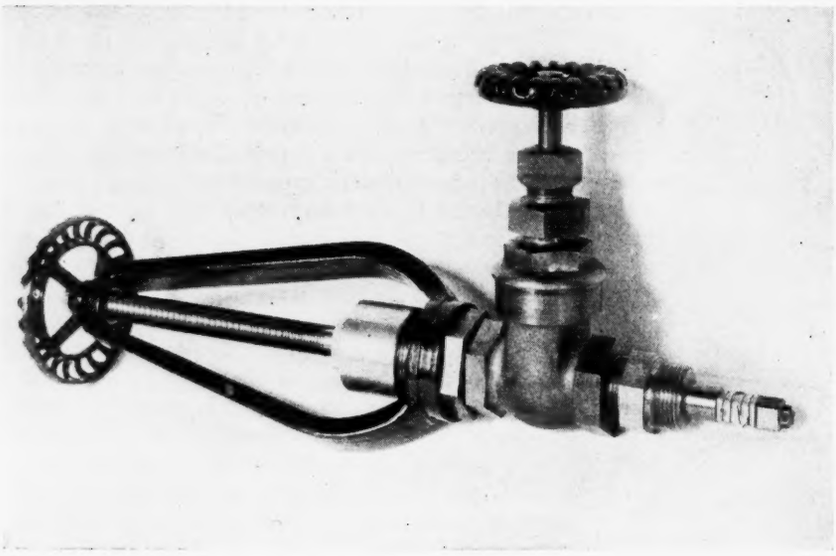
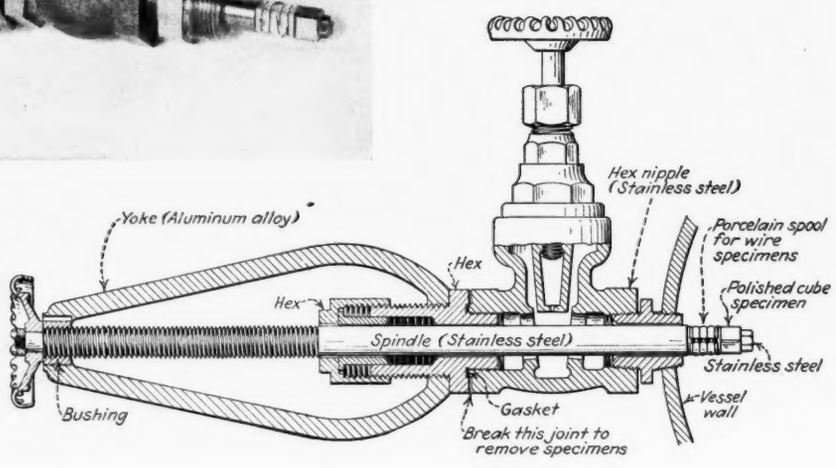


Fig. 1 (Above)—The corrosion tester consists of a cast aluminum alloy yoke solidly fixed to a brass stuffing box. A stainless-steel spindle projects through the standard gate valve

Fig. 2 (Below)—Specimens (metal cube and wire on porcelain block) may be inserted or removed when vessel is under pressure. There is sufficient space on the spool to wind four wires



quick and delicate tests may be made. The microscope will generally reveal extensive corrosion after exposure for twenty hours or less.

Obviously, this equipment may be used to test the relative resistance of various metals and alloys to a given fluid. Conversely, it may be used to test the relative tendency of various fluids to corrode a particular metal. For the former purpose several testers may be placed side by side to permit of concurrent tests.

Another use of the equipment is to detect changes taking place in the fluids carried in the system. For instance, in a boiler plant in which water is deaërated, testers are useful in checking the effectiveness of the deaërating equipment.

Finally, the tester may be used to measure the rate of deposit of scale, or the character of scale being deposited.

The corrosion tester consists of a cast-aluminum alloy yoke solidly fixed to a brass stuffing box with a hexed-head aluminum follower cap. The stainless-steel spindle projects through a standard gate valve. A stainless-steel hexed heavy nipple connects this to the pressure vessel. The spindle has double lead threads, which work in a bronze bushing in the top of the yoke. Specimens are attached to the end of the spindle with a stainless-steel hexed-head cap bolt.

A straight threaded joint between the yoke assembly and the valve provides means for removing the yoke and spindle assembly with attached specimen for examination. This joint is made tight by means of a copper or other suitable gasket. The stuffing box is packed with graphite ring packing.

All parts are standard and interchangeable for use with either 200-lb. brass or 400-lb. monel valves.

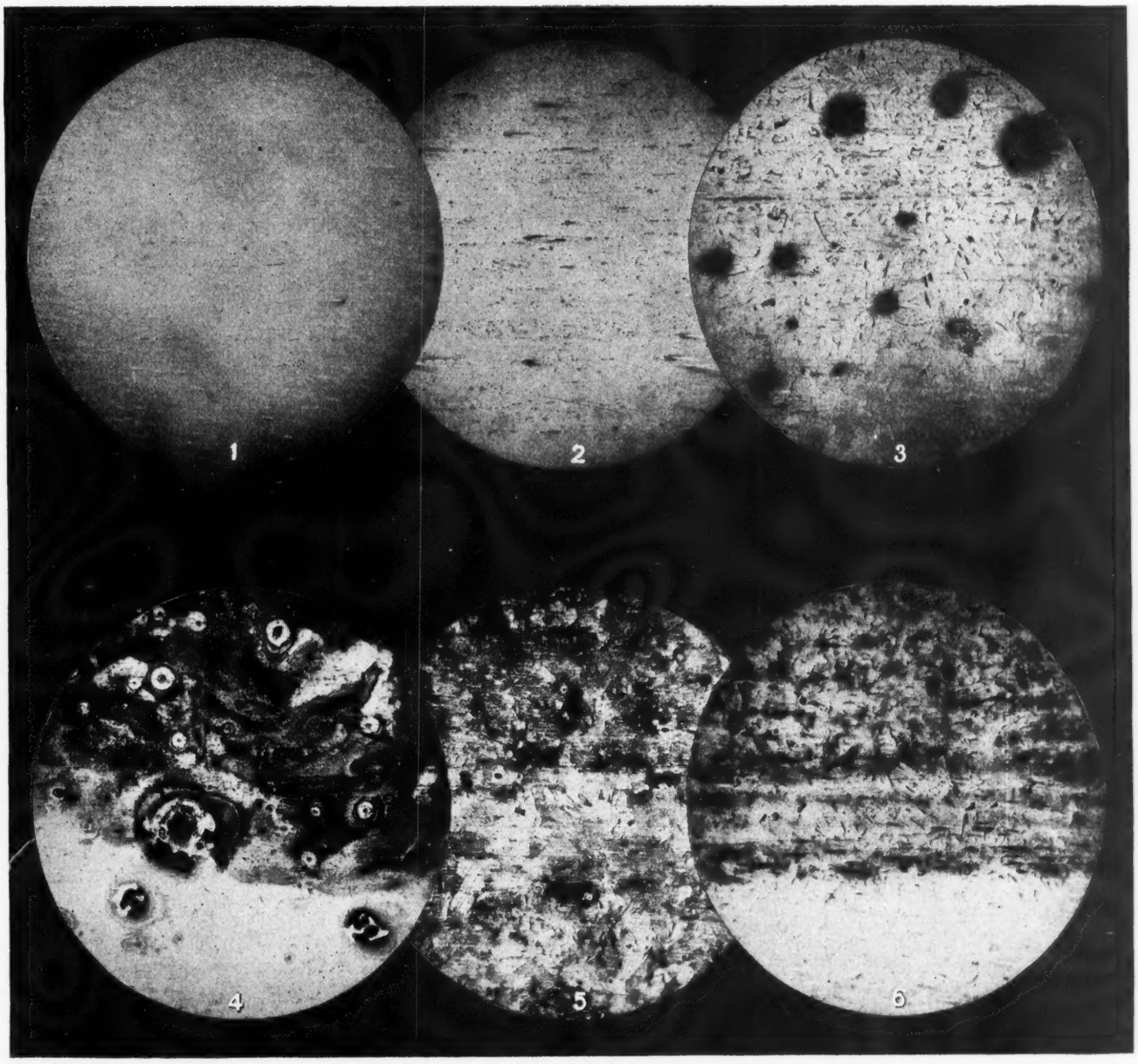


FIG. 3—PHOTOMICROGRAPHS OF BESSEMER-STEEL CUBES IMMERSED FOR 20 hr. AT ROOM TEMPERATURE IN 500 CC. OF WATERS AS FOLLOWS:

No. 1—Prepared specimen before subjecting to test. No. 2—Test in freshly boiled distilled water free of O_2 and CO_2. No. 3—Test in freshly boiled distilled water free of O_2 but containing 1.89 grains per gallon of CO_2. No. 4—Test in freshly boiled distilled water free of CO_2 but containing 1.45 grains per gallon of O_2. No. 5—Test in distilled water containing 0.61 grains per gallon of O_2 and 0.12 grains per gallon of CO_2. No. 6—Test in City of Reading tap water.

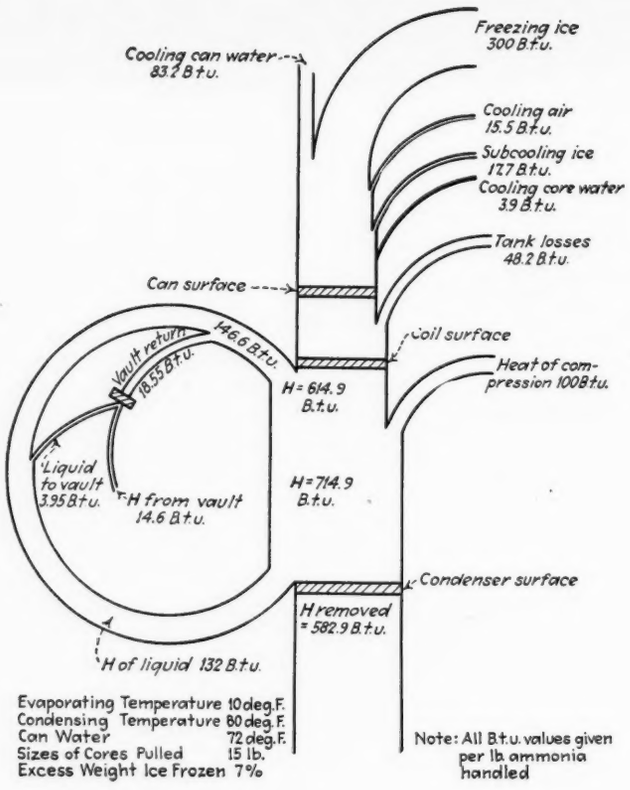


Fig. 1—Heat-flow diagram for typical ice plant

By M. F. KNOY

Heat Balance Of an Ice Plant

A HEAT-BALANCE diagram has been constructed by the author for what might be termed a typical ice plant. Naturally this raises the question as to what constitutes a typical plant. And since individual plants differ so widely as to details of design and operation, it is doubtful whether any one plant could be found that could be considered as representative of them all.

However, the typical ice plant may be said to have a capacity of between 20 and 100 tons of ice per day. It uses raw water for ice making, low-pressure air for agitation, and pulls cores. It has a daily ice-storage vault, refrigerated by direct-expansion coils, and is without a liquid ammonia forecooler or a can-water forecooler. The suction pressure is from 15 lb. gage to 30 lb. gage, and the discharge pressure from 130 to 170 lb. gage.

Of course, there are many plants in operation which differ in almost every detail from the above description yet which may be better suited to their respective conditions than a so-called typical plant would be. Such are the plants that come over or under the above size limits, plants producing inferior ice for non-domestic use, and plants adapted to unusual conditions of water quality or temperature. Some of the latter group of plants may use high-pressure air for agitation, pull unusually large cores and vary at other points. But in any case the heat balance of the typical plant will give a general idea of what the heat balance in any particular plant should look like, and by proper corrections may be adapted to any given set of conditions.

A heat-flow diagram is shown in Fig. 1 and the heat balance in Fig. 2 for a typical plant operating under the following conditions: Evaporating temperature, 10 deg. F.; condensing temperature, 80 deg. F.; can water, 72 deg. F.; size of cores pulled, 15 lb. per 300-lb. block; agitating air, 0.6 cu.ft. per minute per 300 lb. can. The B.t.u. values shown on the flow diagram are based upon the net heat from various sources per pound of ammonia handled, and those shown in the heat-balance diagram are on the bases shown on the diagram. The B.t.u. per pound of ice as sold, which is taken as 7 per cent less than the actual weight frozen, and as percentages of the total refrigerating load, are also shown in Table I.

In a plant of this description the first heat transfer takes place through the can surface. Here the sensible heat of the can water plus that of the core water, the heat introduced by the agitating air, the latent heat of fusion of the ice, and the sensible heat given up by the sub-cooled ice, is all transferred into the brine. Since it was assumed that there would be no water forecooler in the typical plant, the flow diagram shows all of this sensible heat as going into the can.

The chief source of heat in the can, however, is the latent heat of fusion of the ice. This amounts to 144 B.t.u. per lb., or 144 $\times$ 1.07 equals 154.1 B.t.u. per lb. of ice as sold.

The heat introduced into the can by the agitating air is an item which some engineers claim to be negligible. In this case the assumption has been made that the blower will take in atmospheric air at a temperature of

75 deg. and at 70 per cent relative humidity. It is further assumed that after being discharged from the blower the air was cooled to 75 deg. before entering the cans. Under these conditions the net heat introduced by the air will consist of the sensible heat of the dry air above 32 deg. F., plus the latent heat of condensation of the water vapor it will give up on being cooled to 32 deg. F. The water vapor will have a partial pressure of 0.3 lb. per square inch and will weigh 6.59 gr. per cubic foot. The air will have a partial pressure of 14.4 lb. per square inch and will weigh 0.0727 lb. per cubic foot. On leaving the cans the air will carry 2.12 gr. of moisture per cubic foot at 32 deg., or about 1.99 gr. per cubic foot of the original air. Thus it will have lost 4.6 gr. of moisture per cubic foot of the original air. At this pressure water vapor has a latent heat of condensation of approximately 1,058 B.t.u. per pound, or 0.148 B.t.u. per grain. Latent heat would, therefore, amount to 0.148×4.6, or 0.681 B.t.u. per cubic foot of air. Sensible heat would amount to $0.0727 \times 0.24 \times (75 - 32)$, or about 0.75 B.t.u. per cubic foot of air. Total heat introduced would then be $0.75 + 0.68$, or 1.43 B.t.u., per cubic foot of air.

It has been found that with cans 11x22 in. at the top, producing 300-lb. blocks, 12.8 cans per ton of ice per day will be required with brine at 15 deg. The total net heat introduced by the agitating air will therefore be approximately 8 B.t.u. per pound of ice as sold. It will be seen that since this is some 3 per cent of the total refrigeration per pound of ice it is by no means negligible.

If 15-lb. cores are drawn and filled with water at 72 deg. the net heat thus introduced will be $\frac{(72 - 32) \times 15}{300}$ or 2 B.t.u. per pound of ice as sold. The diagram shows this heat as being introduced into the can. As a matter of fact, however, many plants have core water forecoolers which reduce the temperature to 40 deg. or lower before it is put into the cans. This procedure does not change the quantity of heat involved, though it does change the point of entry into the system.

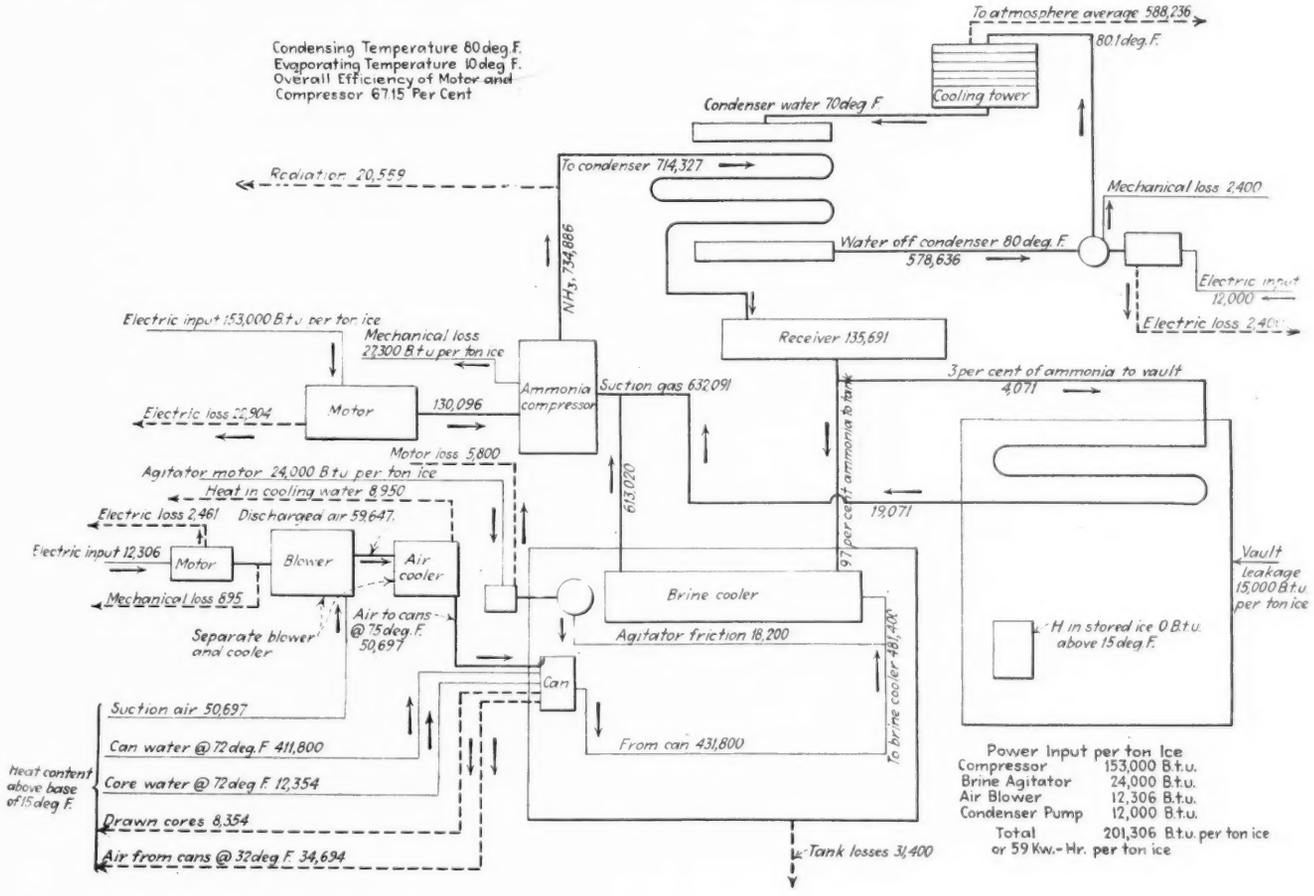
All of the above increments of heat pass out through the can wall and into the brine being circulated among the cans. Other quantities of heat come into the brine through the insulation on the sides and bottom of the freezing tank and through the can covers. Some heat is introduced by the work done on the brine by the agitators. This amounts to 3,413 B.t.u. per kilowatt-hour of work actually performed. The relative amounts of heat added to the brine from these sources vary widely in different plants. In this assumed case all tank losses amount, roughly, to 10 per cent of the total refrigerating load, or 24.8 B.t.u. per pound of ice as sold.

Another source of heat is the daily ice-storage vault, which will require 3 per cent of the total refrigerating load to keep it cold, or approximately 7.5 B.t.u. per pound of ice as sold. On the diagram, Fig. 2, this heat is shown as entering the system at the suction accumulator through the vault return line.

The heat carried by the brine and acquired from the various sources mentioned above is transmitted to the refrigerant through the evaporating coils or brine cooler surface.

With operating conditions as assumed above, the saturated suction gas will have a total heat of 614.9 B.t.u. per pound. The warm liquid will have a heat content of 132 B.t.u., and the net refrigerating effect will

Fig. 2—Heat balance of a medium-sized ice plant Heat-flow figures are in B.t.u. per ton of ice sold, which is 7 per cent less than the ice frozen


Condensing Temperature 80 deg. F.
Evaporating Temperature 10 deg. F.
Overall Efficiency of Motor and Compressor 67.15 Per Cent
To atmosphere average 588,236
80.1 deg. F.
Cooling tower
Condenser water 70 deg. F.
To condenser 714,327
Radiation 20,559
Mechanical loss 2,400
Water off condenser 80 deg. F. 578,636
NHs. 734,886
Electric input 12,000
Electric loss 2,400
Receiver 135,691
Electric input 153,000 B.t.u. per ton ice
Mechanical loss 27,300 B.t.u. per ton ice
Ammonia compressor
Suction gas 632,091
3 per cent of ammonia to vault 4,071
Electric loss 22,904
Motor
130,096
Motor loss 5,800
Agitator motor 24,000 B.t.u. per ton ice
Heat in cooling water 8,950
Electric loss 2,461
Discharged air 59,647
613,020
97 per cent ammonia to tank
19,071
Electric input 12,306
Motor
Blower
Air cooler
Mechanical loss 895
Brine cooler
Vault leakage 15,000 B.t.u. per ton ice
Air to cans @ 75 deg. F. 50,697
Separate blower and cooler
Agitator friction 18,200
H in stored ice 0 B.t.u. above 15 deg. F.
Can
To brine cooler 481,400
Suction air 50,697
Can water @ 72 deg. F. 411,800
From can 431,800
Heat content above base of 15 deg. F.
Core water @ 72 deg. F. 12,354
Drawn cores 8,354
Air from cans @ 32 deg. F. 34,694
Tank losses 31,400
Power Input per ton Ice
Compressor 153,000 B.t.u.
Brine Agitator 24,000 B.t.u.
Air Blower 12,306 B.t.u.
Condenser Pump 12,000 B.t.u.
Total 201,306 B.t.u. per ton ice
or 59 Kw.-Hr. per ton ice

be 614.9 — 132, or 482.9 B.t.u. per pound of ammonia handled.

With saturated suction at 10 deg. and a condensing temperature of 80 deg., the Mollier chart reveals that the theoretical heat of compression will be approximately 85 B.t.u. per pound. Experience shows, however, that under these conditions the usual ammonia compressor will have a volumetric efficiency of only about 85 per cent. Hence the actual heat of compression will be approximately $\frac{85}{0.85}$, or 100 B.t.u. per pound. Since the saturated suction gas carried 614.9 B.tu. per pound, the discharge gas would carry 614.9 plus 100, or 714.9 B.t.u. per pound. And the heat removed in the condenser would be 714.9 —132, or 582.9 B.t.u. per pound of ammonia handled. The 132 B.t.u. reenters the system with the warm liquid.

Though heat-balance diagrams of steam power plants are used to obtain the highest over-all efficiency, seldom are such diagrams prepared for ice or refrigerating plants. Certainly if a refrigerating engineer drew up such a diagram for his plant, calculating the various losses from instrument readings and other data, he might discover that the operation was entirely unbalanced and inefficient

In stating that the suction gas reaches the compressor in a dry, saturated condition, it is assumed, of course, that the suction line is of reasonable length and well-insulated, that the evaporator is operating flooded or practically so, and that a suction accumulator is used to remove excess liquid from the suction gas. These conditions actually prevail in many modern plants.

Reducing Heat Increments to a Minimum

All realize that the production of ice is merely a matter of absorbing heat at brine temperature and discarding it at the temperature of the condensing water. It therefore stands to reason that any reduction in the quantity of heat thus handled per ton of ice made will result in a like reduction in the power requirements. And since Figs. 1 and 2 are graphic representations of the various heat increments that go to make up the refrigerating load, it is well to go over them, one at a time, to discover where reductions may be possible.

The first source of heat is the sensible heat of the can water. The only way that this can be controlled in the typical plant is to make sure that the natural temperature of the water is not increased before it reaches the cans. One offender in this respect is the storage tank or reservoir in a boiler room, near steam piping, or directly exposed to the sunlight. The heat added to the water in this manner is just so much increase in the total refrigerating load of the plant, and should therefore be avoided by insulating the tank, by covering it, or by placing it in a more suitable location.

The latent heat of fusion of the ice is one item over which the engineer has no control, since it is constant under all normal conditions. He can, however, avoid excessive overweight in the ice block. In the heat balance it was assumed that 7 per cent overweight of ice was frozen to take care of shrinkage. This may be too little in some cases of long delivery routes and slow delivery. On the other hand, it may be excessive in cases where the ice is to be used on the spot. Whatever may be the percentage of excess weight decided upon as adequate, the engineer should see that it is strictly adhered to. If 5 per cent is considered adequate and a poorly adjusted can filler or carelessness in filling cores raises the actual excess weight to 10 per cent, then there is a waste of approximately 5 per cent of the total refrigeration.

The next item is the heat introduced by the agitating air. Under the assumed conditions about half of this heat is due to the sensible heat of the dry air and about half to the latent heat of the water vapor lost upon cooling. The portion of heat due to the water vapor is practically eliminated in some plants by having the blower take its suction from under the tank top. The suction air then carries very little excess water vapor, and since it is originally at a low temperature it may reach the cans with less sensible heat than would the air taken in at normal atmospheric temperature. Where it is not feasible to use this cold air for the blower suction, at least some provision should be made to run the discharged air through a cooler to reduce it to atmospheric temperature before going to the cans.

In the case covered by Figs. 1 and 2 it was assumed that 0.6 cu.ft. per minute per can is required for proper agitation. This should be sufficient for a plant having a poor quality of raw water. Many plants will be able to make good ice with considerably less air than this. Some will require more. But whatever the requirements of the particular water in question, no more air than necessary should be used. The engineer should determine from experiment the minimum of air that will give a good quality of ice at various tank temperatures and should use only that amount. It is evident that when operating at low tank temperatures a comparatively large volume of air will be required. But this is no reason why the same volume should be sent through the cans when operating at high tank temperatures during the slack season. In the above case the tank temperature is taken as 15 deg. F., with a freezing time of 46 hr. If the tank temperature is raised to 23.5 deg. the freezing time will be doubled and the total volume of air per ton of ice will likewise be doubled if the rate of agitation is not also reduced accordingly. Instead, then, of the agitating air requiring 3 per cent of the total refrigerating load, as in the above case, it would require approximately 6 per cent of the total. This extra 3 per cent of the refrigerating load is well worth saving.

The heat given up by the ice on being cooled to brine temperature is another constant that cannot be controlled. However, the engineer can avoid waste in this item also by eliminating excessive overweight and abnormally low tank temperatures.

The refrigeration used in cooling core water is based upon the assumption that 15 lb. cores will be drawn. In cases where smaller cores may be drawn without impairing the quality of the ice or unduly delaying the freezing process, a small saving may be realized. The engineer should not pull larger cores than necessary.

The next source of heat shown on the chart is that of tank losses. These will not be subject to direct control by the engineer, since they depend primarily upon the quality of insulation used on the low-temperature

portion of the system. This problem is therefore one to be solved by the owners and builders at the time the plant is designed. Many designers have come to realize that a well-insulated system pays good dividends in the form of increased capacity and reduced operating costs.

Next to present itself is the heat absorbed in the daily ice-storage vault. The comparative magnitude of this item varies widely from plant to plant. It is a function of insulation thickness, size of vault used, temperature carried, and the proportion of time that doors are kept open. In most modern plants the vault is of moderate size and well insulated. If a larger vault than needed

TABLE I—HEAT ABSORBED BY REFRIGERANT

Source of Heat	B.t.u. per lb. Ice as Sold	B.t.u. per lb. of Ammonia Circulated	Per Cent of Total Refrigeration
Latent heat of ice	154	299.8	62.0
Sensible heat of water	42.8	83.2	17.2
Sensible heat of ice	9.1	17.7	3.7
Heat introduced by core water	2.0	3.9	.8
Heat introduced by agit. air	8.0	15.5	3.2
Tank losses	24.8	48.2	10.0
Heat absorbed in vault	7.5	14.6	3.0
Total	248.2	482.9	99.9

has been provided it simply means unnecessary refrigeration losses from this source throughout the life of the plant. The operator can, however, do his part in holding these losses to a minimum by keeping the doors shut as much of the time as is possible. If ice must be cut at the vault entrance an anteroom for this purpose should be partitioned off from the rest of the vault.

Some of the sources of heat discussed form only a small proportion of the total refrigerating load of the plant, but they have been considered nevertheless. It is through the knowledge and control of these various losses that the competent refrigerating engineer distinguishes himself from the mediocre engineer. In doing this he also contributes to the welfare of the business by thus keeping the cost of producing ice at a minimum.

In preceding paragraphs the discussion has been centered on ways and means of keeping the total refrigerating load on a plant at a minimum for a given ice output. The next problem is to determine how the plant can perform this refrigeration with the expenditure of as little energy as possible. Since the ammonia compressor usually consumes more than half of the total power required in the production of ice, a close study of the causes of greater power consumption by this machine is justified.

It is a well-known fact that the heat of compression per pound of ammonia varies with the ratio of compression. In other words, the greater the difference between suction and discharge pressures the greater the heat of compression or power consumption. The engineer should therefore endeavor to operate with the suction pressure as high and the discharge pressure as low as possible.

One obvious way to keep the suction pressure high is to keep the freezing tank at as high a temperature as will produce the required amount of ice. An equally obvious way to keep the head pressure low is to keep the condenser purged of foul gases at all times. Perhaps the chief factor determining the difference between suction and discharge pressures is the area and condition of the heat-transfer surfaces. The proper area of these surfaces should have been taken care of in the design of the plant, but it is the duty of the operating engineer to see that their condition will facilitate heat transfer.

The can surface is the first heat-transfer surface through which the heat must pass, and its condition does not, as a rule, become such as will greatly hinder the process. The circulation of brine among the cans may become impaired, however, due to broken baffles or bulkheads or to faulty agitator performance. Maintaining proper brine circulation is the chief means of insuring rapid transfer of heat from the cans to the brine. The brine should also be kept at the maximum level, as a low brine level greatly retards freezing, requiring a lower brine temperature and hence a lower suction pressure for the production of a given amount of ice.

The evaporator surface is the next point of heat transfer. The process may be retarded at this point by poor brine circulation or by the fouling of the surface on the inside with oil. The latter condition may be prevented by frequently draining the accumulated oil from the evaporator. Fouled surfaces on the evaporator require a greater temperature difference between ammonia and brine, and since the temperature at which the brine must be held is determined by other factors this means that a lower temperature and lower suction pressure will be required.

The last heat-transfer surface is that of the condenser. Fouling of this surface has the effect of increasing the head pressure. Under some conditions the condenser surfaces will need cleaning every few days if the compressor power is to be kept at the minimum.

A final factor in determining the head pressure is the temperature of the cooling water. Where this is drawn from wells or natural bodies of water there is little that the engineer can do to control its temperature. But where cooling towers or spray ponds are used he will find that attention to the proper operation of these devices pays good dividends in the form of reduced power bills.

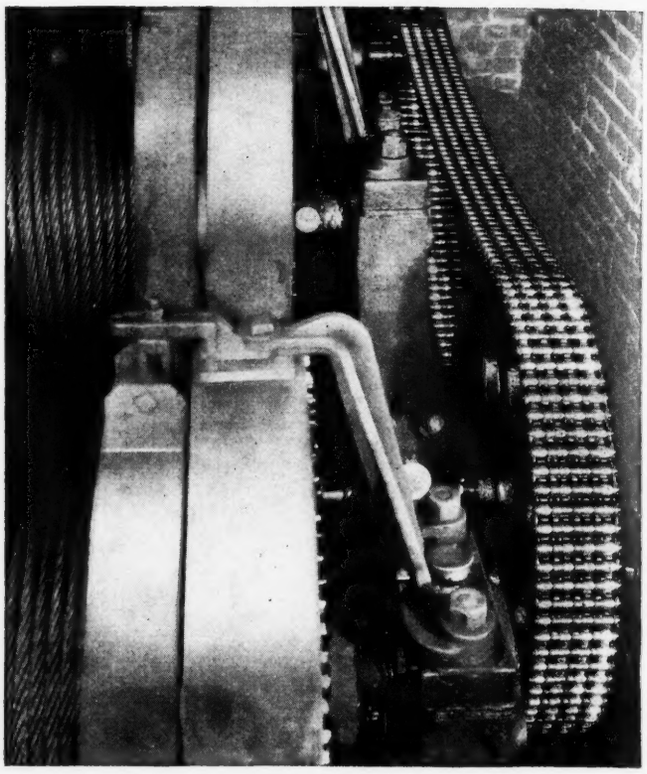
Condition of the Compressor

When everything possible has been done to reduce the quantity of heat going into the system per pound of ice produced, and when the condition of the heat-transfer surfaces has been looked into so that there will be as little difference as possible between the evaporating and condensing temperatures of the refrigenant, there remains yet another possible source of power waste. This is the compressor itself. The motor and compressor should, of course, be designed for high efficiency; but the engineer is not responsible for this feature. He is, however, charged with the responsibility of seeing that the moving parts of the compressor are kept in good working order. Adequate lubrication is the first step toward this end, and the next is periodic inspection with repairs and renewal of parts when necesary.

If these precautions are observed, the heat of compression will remain in proportion to the other heat sources as shown on the diagram, power bills will be kept at a minimum, and the study of the plant heat balance will have been rewarded.

▼

What is believed to be the smallest switchboard ever designed is being installed on the new naval airship Akron for controlling power and lighting circuits. This switchboard will control the generators, electric motors, storage battery charger, and the circuits to the generator room. It will also control circuits to the engine room, control room, radio room, the fire control system, the interior lights, gangway lights, running lights, instruments, electric fans, telephones, and the galley equipment. Including all equipment on front and rear panels, the switchboard is only 42 inches wide, 35 inches high, and 12 inches deep. Its total weight is 200 pounds. Over 2,170 feet of wire were used for connections.



This quadruple roller chain connects a 40-hp., 870-r.p.m. motor to a hoist, and stands overloads that almost stalls the motor

By W. A. WARRICK*

Selecting Roller Chain To Suit the Drive

ADAPTABILITY to meet a wide range of requirements, center distances of sprockets and sprocket ratios, multi-center drives, the use of idlers, vertical and horizontal drives, applications for sprocket speeds up to 3,600 r.p.m., ranges of chain size available, and the data necessary to determine the correct chain for a drive are factors considered

ROLLER-CHAIN drives, like other types, improperly chosen or misapplied, can only be sources of unnecessary expense and anoyance, regardless of careful installation, lubrication and maintenance. The first requirement of any drive is dependability. When drives are to be subjected to occasional severe shocks, which must nevertheless be positive, the use of shear pin sprockets satisfies the conflicting requirements. The size of the shear pin section is established by the degree of protection desired.

Resistance to abuse is a valuable quality of roller-chain drives. The character of performance of heavy motor trucks utilizing roller chains and sprockets is indicative of their ability to withstand temporary misalignments, shock loads, high speeds, exposure to water and abrasives, and limited lubrication.

Roller-chain drives may be installed and removed easily and quickly without special tools, particularly for those applications requiring occasional changes in drive ratio, and when sprockets are so located that their replacement necessitates extensive dismantling of complete units, wheels made with split plates and hubs offer added convenience.

The economy of these drives is a factor which has contributed greatly toward their wide usage. First costs are low because standard chains are made for stock in substantial quantities. When conditions permit, stock sprockets are used, resulting in an additional saving compared with the cost of wheels made to individual specifications. Running costs are moderate because lubrication and maintenance expense are low.

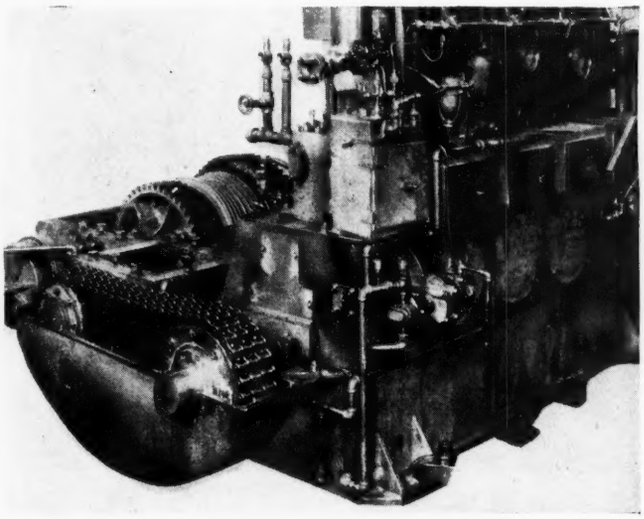
The high efficiency of roller-chain drives is an attribute of their simple construction. Their efficiency, in the neighborhood of 98 per cent when new, is maintained with practically no tapering off until normal wear requires replacement. Statements as to the exact efficiency are apt to be misleading, because this is affected to some degree by variables of design and conditions of service.

Roller-chain adaptability has a strong appeal to those who design equipment to meet a wide range of conflicting requirements. Extreme compactness is possible where width, height and length are restricted. Center distances of sprockets may vary widely. There are few instances where the difference of a few inches in this dimension accounts for the difference between satisfactory and unsatisfactory performance. No fixed upper limit for center distance can be established. Location of sprockets

*Mechanical engineer, Diamond Chain & Manufacturing Company, Indianapolis, Ind.

so close that their teeth barely clear is not best practice, but when this is necessary, successful operation can be had.

The symmetry of roller chains, which make them capable of reversed flexing of joints, frequently solves apparently complex problems of design by the use of one chain for driving several sprockets. Although two-sprocket drives are more frequently encountered than multi-center drives in which there is more than one driven shaft, the latter are not at all unusual. Shafts may be positioned where convenience dictates and without compromise to suit restrictions of the drive. Idlers may be used to direct the chain's path clear of intervening machine elements and they may be inside or outside of the chain.



Diesel engine connected to logging hoist by a triple-strand roller chain

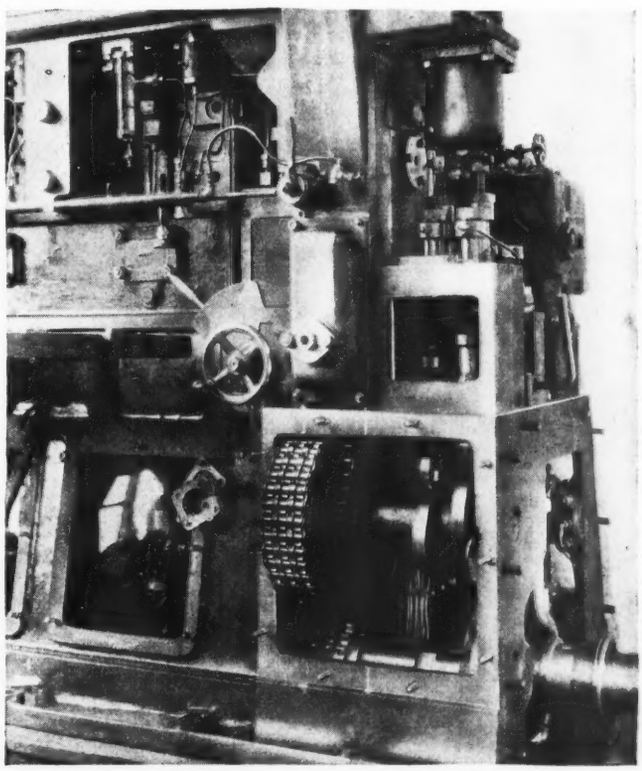
Any angle of the sprockets' centerline with the horizontal may be approved. Drives with vertical centers having the small sprocket below are less desirable than those with horizontal centers for which the weight of the slack strand serves somewhat as an automatic take-up. There are, however, many thousands of high-speed vertical-center roller-chain drives establishing good performance records. It is desirable, but not essential, that the larger sprocket be below and that center distances be adjustable.

The usual plane of roller-chain operations is vertical, sprockets having horizontal shafts, but chains can be run in a horizontal plane, the shafts being vertical. This arrangement is practicable, even if not ideal, especially if centers are adjustable and relatively short. The bevel of indice plates of the chain provides a guiding effect. Such roller-chain drives, properly designed, have satisfactory life. Drives with shafts parallel but between the horizontal and vertical planes are rare, but are capable of adequate performance, although chain and sprocket life is not as great as when the shafts are in a horizontal position.

Ratios of roller-chain drives as great as 7 to 1 are not unusual, and even larger ratios are feasible. When large ratios are required a series of two or more drives of moderate ratio are preferred to one of the same total ratio. For relatively slow speeds, drivers having as few as 7 to 8 teeth may be used for the faster-running shaft. For extremely restricted locations, sprocket teeth have been cut directly in the shafts, sections of which have been upset somewhat to form the sprocket blanks. Large sprockets may have more than 100 teeth, but this is rare in combination with the minimum size of companion sprocket. Heat-treatment of the smaller sprockets provides for approximate equality of rate of tooth wear with larger wheels. Roller-type chains are suitable for shaft speeds of 3,600 r.p.m., and, when all conditions are favorable, for even higher speeds. At the other extreme, both large and small chains may be used for speeds so slow that the motion is almost imperceptible. For each pitch of chain there is a more or less elastic limiting speed that should not be exceeded without approval of the chain manufacturer. The shorter the pitch the lighter the weight, and the greater the roller size in proportion to the pitch the higher may be the shaft's speed.

For very high speed drives, it is necessary to utilize short-pitch chains. The small bearing areas of these limit their power-transmission capacity. The usual maximum at 3,600 r.p.m. being about 20 hp. For very slow speeds and heavy loads the largest chains may be used, but the majority of applications are between the two extremes of high and low speed.

The power-transmission capacities of individual chains are greatest at lineal speeds of 1,500 to 1,800 ft. per minute. The maximum horsepower to which each pitch of chain may be considered suited, may be assumed to be that of paired quadruple chains. This is, substantially, eight times the capacity of single-strand chains as given in the table. Roller chains have been assembled in units of as many as 8 strands, but that is unusual except for the smaller pitches. Chain speeds greater than 1,800 ft. per minute do not necessarily violate good practice if the result of large sprocket size rather than of running the chain over sprockets at shaft speeds greater than recommended in the table given on the last page.



Triple- and single-strand roller-chains drive the camshaft, the fuel, lubrication and water pumps on this 8-cylinder diesel engine

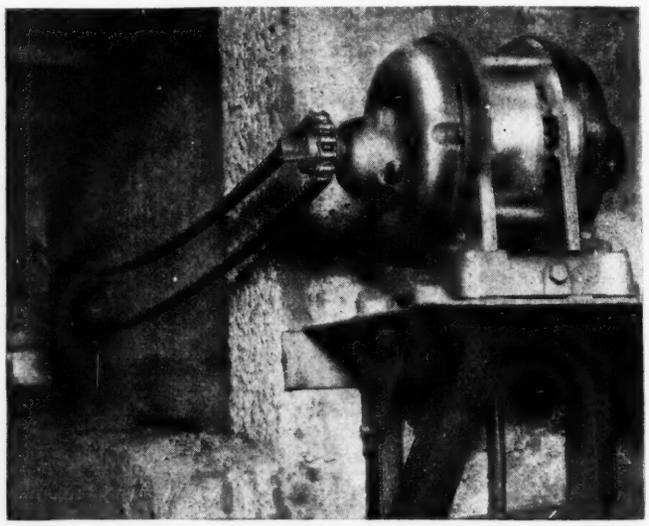
The transmission of power from electric motors is well within the field of roller-chain drive utility. For 1,800-r.p.m. motors, 40 hp. is the maximum usually recommended. With 1,200-r.p.m. motors 75 hp. can be handled advantageously and for 900- and 600-r.p.m. motors 150 and 200 hp., respectively. For slower-speed driving shafts maximum power capacities range from 360 hp. at 375 r.p.m. to 500 hp. at 240 revolutions per minute.

Selection of roller-chain drives is simple. The speed of the faster-running sprocket establishes the maximum chain pitch, and the chain's bearing area suitable for the rotative speed determines the power-transmission capacity. The number of sprocket teeth, the chain pitch and the rotative speed establish the lineal speed. The capacity of single-strand chain at the lineal speed involved may be determined from the table. For small drives, the longest pitch suitable for the shaft speed may be of greater capacity than needed. In such instances shorter-pitch chain should be selected. If the capacity of single-strand chain is inadequate, multiple strands may be used. Multiple chains may be run at the same shaft speeds as single-strand chains of the same pitch, roller diameter and roller width.

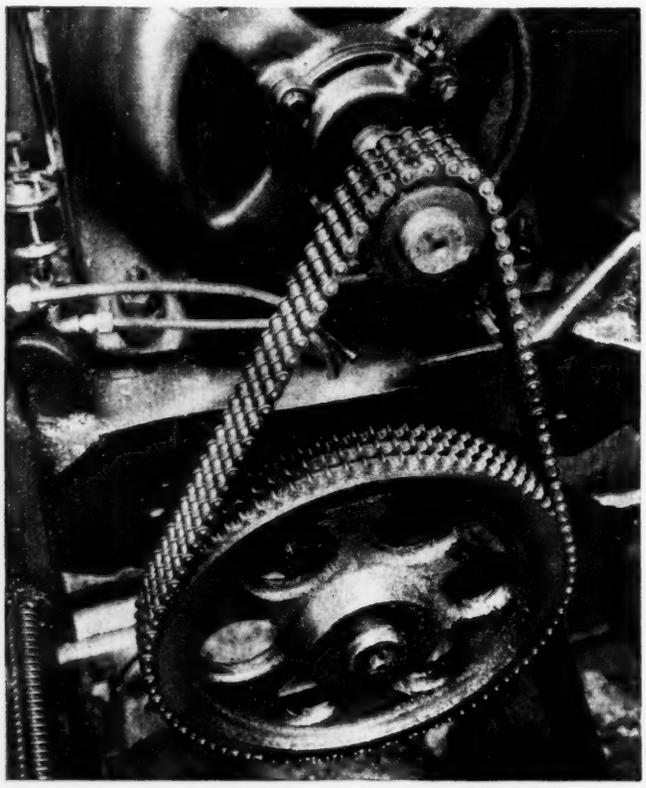
The capacities and rotative speeds given in this article are flexible. They are intended as a general guide and one not applicable without regard to the variables that affect drive performance. Similar tables are published by all manufacturers of roller chains. Comparison of the widely varying ratings of different makes for identical chains may be puzzling. However, it should be realized that these differences, instead of measuring the relative mechanical values, reflect the various standards of performance expected. The higher ratings assume more favorable conditions of operation and contemplate less extended service life.

With the assistance of the complete data offered by roller-chain manufacturers, the design of roller-chain drives is not complex; although observing a few simple principles will contribute to best results. All of the chain makers maintain engineers whose services are available either for making original recommendations of chain and sprockets or for checking specifications submitted to them.

When center distance of sprockets for a chain drive can be selected, this dimension should be chosen to provide an arc of not less than 120 deg. but is not always essential. In general, the center distance of two-sprocket drives in relation to the sprocket size should be such that the angle between the driving and slack strands of the chain is not more than 60 degrees.



One of ten ash drags driven by 5-hp., 1,150-r.p.m. motor through single-strand roller chain, with sprocket-center distances of 5 to 15 feet



Although runn'ng in an inclined plane, this triple-strand roller chain connects a 7.5-hp., 1,750-r.p.m. motor to its load

For long centers and small ratios, the upper strands must do the driving to prevent interferences of the upper and lower runs unless the upper strand may be supported by an idler. This practice may be approved if the speed is slow and the load uniform. Under some circumstanances it is practical to use chain drives where the center distances vary constantly.

Roller-chain drives with fixed centers are common, wear being compensated for by shortening the chain when necessary. It is better to adjust the center distances when this is convenient, because it permits better control of the chain slack.

For all multi-sprocket drives a fairly generous wrap arc on each wheel is desirable, especially for the driver. This distributes the load among the teeth and facilitates proper meshing. A mesh of less than five teeth and a chain span of less than five or six pitches between sprockets is to be avoided.

On two-sprocket drives, chains articulate four times in one complete cycle of an endless length. This operation occurs under the working loads at the driver and follower ends of the driving spans and under loads due only to the weight of the slack strands at both ends of the latter. Slack strand idlers, adjusted manually, do not require over-chaining to compensate for their presence, but spring-loaded and weight-loaded idlers cause extra wear. Idlers meshing with driving strands are used when more exact timing relation of driving and following sprockets is necessary than can be obtained with one idler. Duplex idlers may be adopted in such instances, two wheels being established on fixed centers

with relation to each other, but adjustable as a unit for chain take-up in both strands, one idler contacting the driving strand and the other meshing with the slack strand. Sprockets are ordinarily used for idlers, but disks without teeth and even shoe idlers on which the chains will roll can occasionally be recommended for slow chain speeds or intermittent service.

What the Manufacturer Should Be Told

When manufacturers of roller chains are consulted for original recommendations of drives or for checking selections previously made, their work can be most effective only when complete specifications are made available. These should include not only dimensional information, but also conditions of operation and performance requirements.

For all shafts, rotative speeds should be given, accompanied by information as to whether exact ratios are necessary. Shaft diameters, key-seat and set-screw sizes and available length along the shafts are essential information. If plate sprockets are required for fastening to hubs or flanges, bores and bolting dimensions must be given, and also it must be known whether sprockets are to be split-, single- or double-hubbed.

Direction of shaft rotations should be indicated, and data on distances between centers should be complete, whether fixed or adjustable, and possible range of adjustment. Limitations on allowable diameters over the chain on the sprockets should be mentioned if restricted, as these control the size of the larger sprockets. When sprocket diameters are limited the use of short chain pitches will avoid an unusually small number of teeth. Requisite capacity—bearing area of chain—should be obtained by increase in pin length with a multiplication of strands rather than by pin diameters as for longer-pitch single-strand chains.

HORSEPOWER AND LOADS FOR STANDARD SINGLE-ROLLER CHAINS

Chain No.	Pitch, In.	Width, In.	Roller Diameter, In.	Max. R.P.M. of Sprockets	The upper figures are rated horsepowers. The lower figures are loads in pounds. Chain Velocity in Feet Per Minute									
					50	100	200	300	400	600	800	1,000	1,200	1,500
35N	3/8	3/16	0.200	3,600	0.30 197	0.55 183	0.97 161	1.30 143	1.56 129	1.96 108	2.24 93	2.45 81	2.60 72	2.80 62
41	1/2	1/4	0.306	2,900	0.36 240	0.68 224	1.18 196	1.59 174	1.91 157	2.39 132	2.73 113	2.99 99	3.20 88	3.40 75
40	1/2	5/16	0.312	2,600	0.50 328	0.92 305	1.62 267	2.17 238	2.60 215	3.26 179	3.73 154	4.08 135	4.40 120	4.70 103
50	5/8	3/8	0.400	1,900	0.78 521	1.47 484	2.57 425	3.45 379	4.14 342	5.18 285	5.93 245	6.50 215	6.90 191	7.40 163
60	3/4	1/2	0.469	1,500	1.13 750	2.11 698	3.70 612	4.96 545	5.96 492	7.46 410	8.54 352	9.35 309	10.0 276	11.0 236
80	1	5/8	0.625	940	2.02 1,332	3.75 1,240	6.58 1,088	8.82 967	10.6 873	13.3 728	15.2 626	16.6 548	17.7 487	19.0 417
100	1 1/4	3/4	0.750	645	2.93 1,940	5.46 1,800	9.61 1,580	12.8 1,410	15.4 1,270	19.3 1,060	22.1 912	24.1 798	26.0 711	28.0 609
120	1 1/2	1	0.875	520	4.41 2,920	8.20 2,710	14.4 2,380	19.3 2,120	23.2 1,910	29.0 1,590	33.2 1,370	36.3 1,195	39.0 1,068	42.0 916
140	1 3/4	1	1.000	370	5.31 3,510	9.89 3,260	17.3 2,860	23.2 2,550	27.9 2,295	34.9 1,916	39.9 1,650	43.7 1,444	47.0 1,284	50.0 1,101
160	2	1 1/4	1.125	325	7.25 4,790	13.5 4,460	23.6 3,910	31.5 3,480	38.1 3,140	47.6 2,620	54.5 2,250	59.7 1,975	64.0 1,755	68.0 1,506
200	2 1/2	1 1/2	1.562	240	11.4 7,530	21.5 7,100	38.1 6,300	51.0 5,600	61.3 5,050	76.7 4,220	88.0 3,630	97.0 3,200	104.1 2,860	112.2 2,470

The power to be transmitted, average, maximum and minimum, and the relative durations of the loads will influence the capacity of the drive chosen. Expected hours of service annually is important. With all other specifications identical, a chain drive suitable for intermittent service is not equally so for continuous service. Drives for seasonal service or for stand-by in case other equipment fails should be designed with the time factor in mind if they are to give the required service without unnecessary cost.

The nature of the driving unit should be mentioned. Impulsive delivery of power by single-cylinder internal-combustion engines and unusually heavy-starting loads are no more desirable for roller-chain drives than for other types of transmission equipment. The characteristics of electric motors and multi-cylinder engines are particularly favorable for these drives.

The load character imposed by the driven unit has an important influence on the design of the whole drive. Pulsating loads imposed by reciprocating units usually require overchaining, especially for single-cylinder units, unless service-hours are limited. Smooth loads such as those of centrifugal pumps and fans are as favorable for chain drives as for other types of driving equipment, especially if they are not subjected to frequent starts and stops.

Lubrication is important in its relation to chain and sprocket life and should be included in drive specifications. This feature will be discussed in the next article.

The desired standard of noise level should be taken into account in designing roller-chain drives. Those selected for extreme quietness are much different from drives where noise is of minor importance. The degree of difference may be appreciated when it is realized that the power-transmission capacity of a given single-strand chain and that of a four-strand chain of half that pitch are substantially equal. However, the maximum allowable shaft speed for which a quadruple-strand chain may be used is close to three times as great as that for which the single-strand chain of equal capacity may be approved. Sprocket diameters being equal, shorter pitches and correspondingly greater numbers of teeth plus greater multiplication of chain strands foster low noise levels.

Relation of Chain Capacity to Power

When selecting roller-chain drives, the importance of the equipment should be taken into account in establishing the relation between the potential capacity of the chain and sprockets and the power to be transmitted. On machinery where freedom from interruptions is paramount, it is false economy to select a drive on the same basis as for equipment used intermittently. The cost of drives is so small compared to the equipment they operate that it is unwise to cut corners too severely in balancing drive cost against total costs.

Correctly selected and given reasonable care, roller-chain drives, by virtue of their intrinsic simplicity and substantial construction, meet both high-speed and low-speed power-transmission requirements.

FUSE PERFORMANCE In Relay Service

Tests results show how accurate fuses of the same size are in time of interrupting an overload, how sensitive they are to load changes, and how selective two or more fuses, of different sizes in series, are in clearing a fault on a power system.

By H. D. BRALEY
Assistant Engineer, Protective Equipment
The New York Edison Company

Fig. 1—Fuse designed to have extra-long time delay, approaching that of a thermal cutout

THE performance of a fuse as a relay may be considered particularly as it fulfils the requirements of accuracy, sensitivity and selectivity. The characteristic of accuracy may be compared only between fuses of the same type and rating, since a fuse can function but once and therefore offers no means of comparing successive operations.

Variations in blowing time of fuses of exactly the same rating may range up to 500 per cent under identical overload conditions. This is shown in Table I, which gives the results of comparative tests made under standard conditions, each test being the average of several. All of these tests come within the limits specified by standard code requirements, so that the ability of a fuse to meet code requirements is no guaranty of extremely accurate performance. Fuse No. 1 in this test is of a special type designed to give an extra long time delay, approaching the characteristics of the thermal cutout. It is therefore not fairly comparable to the other four, which are of usual construction. The value of the additional time lag of No. 1 fuse is quite apparent. This fuse would not be affected by short time overloads, yet its blowing time is within the limit stipulated by code requirements for safe operation. The fuse's construction is shown in Fig. 1. Additional metal used in the link construction increases the heat-storage capacity and thereby increases the blowing time under short-time moderate overloads.

The degree of accuracy in the time required to clear a short circuit possible by using fuses of the same manufacture is indicated by the test results given in Table II. While the per cent variation of any one fuse from the average in any test group is quite large, this percentage will not necessarily hold at more moderate overloads. Contact resistance will raise the temperature, causing a fuse to operate at currents below normal rating. Connections made to heavy terminal lugs or busbars will lower the temperature by heat conduction, and will require currents higher than normal to blow a fuse.

A fuse's sensitivity is a measure of its response to changes in current. This response is the temperature rise, and is proportional to the square of the current, assuming no heat is lost through radiation or conduction. Because there is some heat lost in these two ways, the time of operation is not exactly in inverse ratio to the current squared. It is particularly so in the larger sizes, but nevertheless the sensitivity of fuses is excellent. The increasing sensitiveness at higher values of current is a desirable feature. Aside from the matter of selectivity, it is most important that severe overloads be cleared in the shortest possible time.

Changes in ambient temperature will affect a fuse's operation to some extent, but will not be a disadvantage if the protected equipment is subjected to the same

TABLE I—OVERLOAD TESTS ON 250-VOLT INCLOSED FUSES OF VARIOUS TYPES AND MANUFACTURE*

Rating of Fuse, Amperes	Overload, Per Cent	Average Time in Seconds — Fuse No. 1	Fuse No. 2	Fuse No. 3	Fuse No. 4	Fuse No. 5	Max. Time, Code Rules
30	50	40.9	21.7	14.8	42.0	33.0	60.0
	100	11.5	4.8	2.8	4.5	6.0	.....
	150	5.4	2.3	1.5	2.0	3.0	.....
60	50	103.3	54.5	44.6	92.8	66.0	120.0
	100	27.7	11.5	6.8	16.7	16.0	.....
	150	11.7	5.0	3.1	6.5	7.0	.....
100	50	184.8	38.6	61.5	152.1	77.0	240.0
	100	43.8	10.0	9.4	9.4	17.0	.....
	150	16.7	4.6	4.8	3.7	9.0	.....
200	50	300.8	57.7	109.5	195.1	98.0	360.0
	100	58.6	13.9	10.3	12.7	29.0	.....
	150	23.4	5.9	5.2	5.4	14.0	.....
400	50	316.6	56.0	100.9	304.0	169.0	720.0
	100	64.8	13.6	9.8	17.3	35.6	.....
	150	22.0	5.8	5.0	6.5	17.1	.....
600	50	572.2	58.6	60.5	509.7	168.0	900.0
	100	70.8	12.3	8.9	30.2	38.0	.....
	150	31.4	5.2	4.6	8.6	18.4	.....

*Test values from Bussman Mfg. Co. bulletin and taken from E.T.L. Report 8-25-30.

TABLE II—RESULTS OF 60-CYCLE A.-C. SHORT-CIRCUIT TESTS ON 250-VOLT INCLOSED RENEWABLE FUSES

Fuse Rating, Amperes	Peak-Current, Amperes	Seconds to Clear Circuit
150	1,180	1.40
	1,100	1.41
	1,100*	1.37
	1,100*	1.25
	1,100*	1.30
150	1,700	0.083
	1,700	0.082
	1,700	0.083
	1,700	0.066
	1,700	0.075
	3,130	0.019
	3,130	0.023
	3,130	0.022
	3,130	0.026
	3,170	0.019
400	5,040	0.076
	4,980	0.075
	4,920	0.064
	4,920	0.054
	5,040	0.057
	9,160	0.031
	7,780	0.037
	9,360	0.023
	7,580	0.029
	8,270	0.022

*Approximately.

TABLE III—RESULTS OF 60-CYCLE SHORT-CIRCUIT TESTS ON 250-VOLT, INCLOSED RENEWABLE CARTRIDGE

Test No.	Ampere Rating of Fuses: Service Side of Switch	Ampere Rating of Fuses: Load Side of Switch	Max. Inst. Current, Amperes	Remarks
1	200	100	3,550	The 100-amp. fuse opened circuit in 0.008 second.
2	200	150	6,070	The 150-amp. fuses opened circuit in 0.009 second.
3	400	200	6,650	The 200-amp. fuses opened the circuit in 0.009 second.
4	400	200	7,220	The 200-amp. fuses opened the circuit in 0.016 second.
5	200	150	8,500	The 150-amp. fuses opened the circuit in 0.012 second.
6	200	150	4,000	One 200-amp. fuse opened the circuit in 0.014 second.
7	200	150	1,840	One 150-amp. fuse opened the circuit in 0.10 second.
8	200	150	1,300	One 150-amp. fuse opened the circuit in 0.175 second.

TABLE IV—LOW-TENSION CARTRIDGE-FUSE CHARACTERISTICS

As a Circuit Interrupter	As a Relay
Rating. 600 Volts, 600 Amp., Max.	Accuracy. 5 per cent to 10 per cent on fuses of same make. Affected by terminal conditions.
Capacity. 110 per cent rated load continuously.	
Overload 50 per cent 1 to 15 min. depending on size.	
	Sensitivity. Excellent.
Short Circuit. 10,000 amp., Max.	Selectivity. Poor. Not adapted for close timing. Requires careful selection for moderately good results.
Reliability. Excellent, if of reliable make and properly installed.	
First Cost. Low	Reliability. Excellent.
Maintenance. Low in small sizes and in all sizes of renewable-link type on applications subject to infrequent overloads.	

ambient temperature. It is therefore desirable to install the fuse, when possible, where it is subject to the same ambient temperature as the protected equipment. This precaution should be observed generally in applying protective devices that operate on the thermal principle.

While a fuse has no adjustment for selectivity, as has a relay, some degree of selectivity may be obtained between two or more sets of fuses of different sizes. This

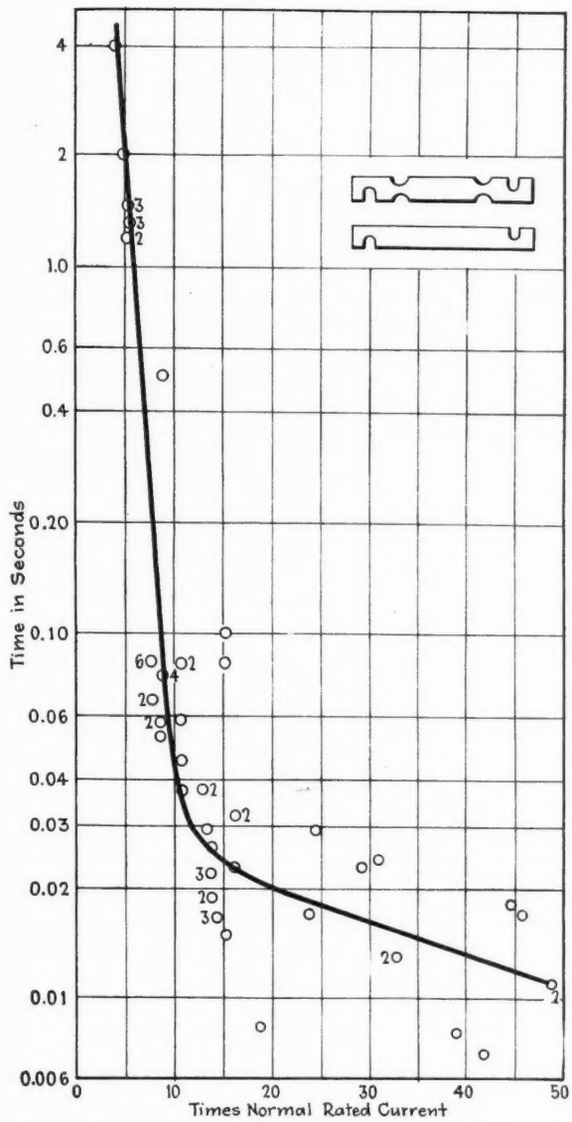


Fig. 2—Results of tests made on different makes and sizes of inclosed fuses of both the renewable and non-renewable types

is particularly so if the overload current does not exceed that of the higher-rated fuses by a very large amount. The highest degree of selectivity obtainable is possible when the fuses are all of the same type and manufacture. It is also essential that fuses of reliable makes be used, to insure correct design, material and construction. Care must be exercised in installing them, to secure good contact, and the terminal connections must be made to suitable conductors or buses to minimize heat-conduction effects.

Selective blowing tests of standard renewable-type cartridge fuses are shown in Table III. These tests were made with two sets of fuses in series. On the service side of a switch was the set having the highest rating, and on the load side the lowest-rated set was placed. The fuse links were taken at random from commercial stocks, but were all of the same manufacture. Selective action was obtained in all cases except test No. 6. In this instance the 200-amp. fuse had been used in the previous test and may possibly have been weakened as a result of that duty. No. 5 was the most severe test of selectivity, as the maximum current was over 42 times the rating of the larger fuse.

Interesting test data are given in Fig. 2, showing the results of tests on various sizes and makes of inclosed fuses of both the renewable and non-renewable types. This illustrates the poor degree of selectivity that can be expected under such conditions. The numbers adjacent to the test points indicate the number of fuses that gave identical results.

These tests indicate that a fair degree of selectivity may be obtained with inclosed fuses of the same type of construction, but not necessarily of the same make, if the larger fuses have a rating equal to twice that of the smaller and the fault current is limited to approximately ten times the rating of the larger fuses. For example, at ten times normal current the average time is around 0.06 sec., required for a fuse to interrupt the circuit, and is the condition for the larger fuses. At twenty times normal current, the condition for the smaller fuses, the time of blowing is on the order of 0.02 sec. If the fuses are of uniform quality and performance it should be possible to obtain selectivity at currents ranging up to thirty or forty times normal fuse rating with a 2-to-1 ratio in fuse sizes.

It should be borne in mind that a fuse is a device with strictly inverse-time characteristics, and if current values are sufficiently high, selectivity can not be expected. The definite minimum time characteristic of certain relays is not obtainable in a fuse or any similar thermal-relay device depending on the heating effect of current on a fusible element. A summary of the chief characteristics of inclosed fuses is given in Table IV.

Chart Simplifies Water-Flow Problems

By ROBERT BALL
Irvington, Calif.

By the use of a storage-reservoir-capacity curve and second-foot scale, problems on the available water for power generation are easily worked out

WATER stored for use in hydro-electric plants is usually measured in terms of acre-feet. An acre-foot of water, as the term implies, is that quantity that will cover an area of one acre, 43,560 sq.ft., 1 ft. deep. This quantity is 43,560 cu.ft., or 325,829 gallons.

Fig. 1 shows an acre-foot elevation graph commonly constructed for use in water-power stations. There is a level below which the forebay should not be drawn, and this may be several feet above the lowest point from which water will flow into the waterway. There is thus a certain depth of water, corresponding to a definite number of acre-feet, that cannot be utilized and should not be included in storage or outflow calculations.

The minimum elevation for the forebay to which Fig. 1 applies is 2,200 ft., which corresponds to 0 ft. depth of water on the graph. The drain valves are at elevation 2,175, consequently 25 ft. of water cannot be used. In this case, however, but few acre-feet are unavailable. The crest of the spillway of this forebay is at elevation 2,250, hence when the reservoir is full the useful depth of water is 50 ft., which corresponds to 2,400 acre-ft. This forebay can be so closely regulated that spill is prevented, therefore elevation 2,250 is taken as the maximum.

A continuous flow of 1 sec.-ft. for 24 hr. equals nearly 2 acre-ft. For all practical purposes 2 may be used. If the quantity of water impounded, namely 2,400 acre-ft., is entirely drawn from storage at a uniform rate in 24 hr. the constant flow during this period will be $2{,}400 \div 2 = 1{,}200$ sec.-ft. The constant flow from this forebay for any other number of hours is equal to the acre-feet to be drawn from the reservoir $\times$ $24 \div 2 \times$ the hours of drawdown. That is, if the 2,400 acre-ft. is to be drawn from the reservoir in sixteen hours the constant flow will have to be $(2{,}400 \times 24) \div (2 \times 16) = 1{,}800$ cu.ft. per second.

If a scale *B*, Fig. 2, is constructed with points 0 and 1,200 the same distance apart as the points 0 and 2,400 on the graph, Fig. 1, the outflow in cubic feet per second from any quantity of water up to 2,400 acre-ft. in 24 hr., can be read directly. To use scale *B*, in this instance, its 0 division must coincide with a vertical line that intersects the curve at a point representing the lower of the two elevations to be considered. The division on the scale vertically downward from the point on the curve indicating the higher of the two elevations is the flow in cubic feet per second that can be drawn off in a period of 24 hr. to bring about this change in elevation.

As an example of using scale *B*, find the cubic feet per second that must flow for a drawdown from elevation 2,240 ft. to 2,210 ft. in 24 hr. Place the scale so that its 0 division is vertically below the point where elevation 2,210 intersects the curve which corresponds to 360 acre-ft. Vertically below where elevation 2,240 intersects 1,800 on the curve, corresponding to 1,800-acre-ft., read 720 sec.-ft. As a check on this result, $1{,}800 - 360 = 1{,}440$ acre-ft., the amount of water drawn from the reservoir in 24 hr. Then the average flow must be $(1{,}440 \times 24) \div (2 \times 24) = 720$ cu.ft. per sec. This value thus checks with that read on the scale.

It is often necessary to find the rate of flow available from a forebay for periods of less than 24 hr. Scale *A* has been constructed for a 4-hr. period. If a given quantity of water is drawn out in 24 hr. it is obvious that the rate of flow must be increased $24 \div 4 = 6$ times to draw out the same quantity during a period of 4 hr. If the rate of flow is increased 6 times, the forebay will be emptied in 4 hr. instead of 24 hr. But, this would require that the 4-hr. flow be $6 \times 1{,}200 = 7{,}200$ sec.-ft. In this case, for reasons given below, a flow of this magnitude is not possible, 1,200 being the maximum value. Therefore, even with 0 inflow this forebay cannot be emptied in less than 24 hours, but that does not change the layout of the 4-hr. scale.

Each of the smallest divisions on scale *B* represents 15 sec.-ft.; therefore each of the corresponding divisions on scale *A* must be 6 times greater, or $6 \times 15 = 90$ sec.-ft. If the 0 points of the *A* and *B* scales coincide, 1,800 on scale *A* will be exactly in line with 300 on scale *B*. However, the 0 points are at opposite ends of the scale, to facilitate its use. By using a triangle, six separate scales can be made available. It is apparent that a similar graph and scale can be used to convert a volume of water into units other than second-feet. The

TABLE I—SECOND FEET FLOW CORRESPONDING TO ACRE-FEET STORAGE*

Duration of Flow in Hours	Acre-Feet 200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000	2,200	2,400
	Flow in Second-Feet											
24	100	200	300	400	500	600	700	800	900	1,000	1,100	1,200
18	133	267	400	533	667	800	933	1,067	1,200	.....	.....	.....
12	200	400	600	800	1,000	1,200	.....	.....	.....	.....	.....	.....
8	300	600	900	1,200	.....	.....	.....	.....	.....	.....	.....	.....
4	600	1,200	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

* Available storage 2,400 acre-ft. and the greatest possible flow is 1,200 second-feet.

values of second-feet on the scale should be great enough to cover maximum net inflow and outflow.

In connection with this forebay the maximum capacity of the penstocks is 1,200 sec.-ft. and of the inflow tunnel, 800 sec.-ft. Due to this limitation it will be found, from Tabe I, that from 400 acre-ft. 200 sec.-ft. can be drawn for 24 hr., 267 for 18 hr., 400 for 12 hr., 600 for 8 hr., and 1,200 for 4 hr. Although the capacity of this forebay is but 2,400 acre-ft., a similar scale can be applied to forebays or reservoirs of any capacity.

Another use for this graph and scale is in connection with the kilowatt load on the plant. Assume that in a station where 83.4 kw. per second-foot is generated it is desired to find the decrease in acre-feet, and the change in elevation that will result if 60,000 kw. is carried for 24 hr., beginning with an initial elevation of 2,240 ft. First of all the load of 60,000 kw. must be converted to equivalent second-feet by referring to a graph or using a slide rule. The rate of flow will be 60,000 ÷ 83.4 = 720 sec.-ft. Make the flow 720 sec.-ft. as given on scale *B* coincide with the vertical line denoting 1,800 acre-ft., which value corresponds to elevation 2,240. Vertically above 0 on scale *B* the curve will be found to be intersected at elevation 2,210. In other words, the forebay elevation will decrease from 2,240 to 2,210 if, with 0 inflow, a load of 60,000 kw. is carried for 24 hr. The drawdown will be 1,800 — 360 = 1,440 acre-ft. With no change in conditions except that the same load is carried for but 4 hr. it will be found, by using 4-hr. scale *A*, that the elevation will decrease to 2,235.6 ft. Drawdown will be 240 acre-ft., which is one-sixth of 1,440, corresponding to the 24-hr. flow.

The scale and graph can be used for another purpose. Suppose that the elevation is 2,208.4 ft., 300 acre-ft., and that it is to be increased to 1,800 acre-ft. in 24 hr. Using scale *B*, with its 0 point in line with the 300 acre-ft. division, beneath the 1,800 acre-ft. line read 750 sec.-ft., the inflow required to store 1,800 — 300 = 1,500 acre-ft. during 24 hours.

This scale is of value when computing the flow into a forebay. With an average load 70,000 kw.; kilowatt per sec.-ft., 83; initial forebay elevation, 2,240.0 (1,800 acre-ft.); final elevation, 2,235 (1,520 acre-ft.), proceed thus: 1,800 — 1,520 = 280 acre-ft., the decrease during 24 hr. On the 24-hr. scale 140 sec.-ft. is found to be the flow necessary to cause this decrease in acre-feet. The outflow, or draft, is 70,000 ÷ 83 = 840 sec.-ft. Since the elevation decreased during this period it is evident that the draft exceeded the inflow. The inflow must then be the difference between 840 and 140, or 700 second-feet.

If the forebay elevation had increased, the inflow would be computed in much the same manner as that just outlined. Assume an average load of 30,000 kw.; 85 kw. is generated per second-foot; initial forebay elevation, 2,208.4 (300 acre-ft.); and final forebay elevation, 2,226 (1,080 acre-ft.). The increase in the amount of water stored during the 24-hr. period considered is 1,080 — 300 = 780 acre-ft. Using the 24-hr. scale it is seen that 780 acre-ft. correspond to 390 sec.-ft. The water flow to the plant is 30,000 ÷ 85 = 353 sec.-ft. In this case the forebay elevation increased, indicating that the inflow exceeded the draft. Therefore the inflow must be 353 + 390 = 743 second-feet.

If this forebay spilled, the number of arc-feet would increase to a value fixed by the depth of spill. To apply a scale to aid in computing the inflow in the event of spill the graph must show the number of acre-feet corresponding to, say, elevation 2,253, or a spill of 3 ft.

Assume that the forebay elevation increases from 2,250 (2,400 acre-ft.) to 2,251 (2,500 acre-ft.) in 4 hr., and that the draft to the plant during this period is 300 sec.-ft. From the 4-hr. scale it will be found that the inflow required to store 2,500 — 2,400 = 100 acre-ft. is 300 sec.-ft. The depth of spill at the end of the 4-hr. period will be 2,251 — 2,250 = 1 ft. The assumption will be made that the spillway discharges 40 sec.-ft. for each 0.1 ft. depth of water. The spill will thus be 400 sec.-ft. at the end of the period considered, or, for all practical purposes, the average spill can be taken as 200 sec.-ft. This average is obtained as follows:

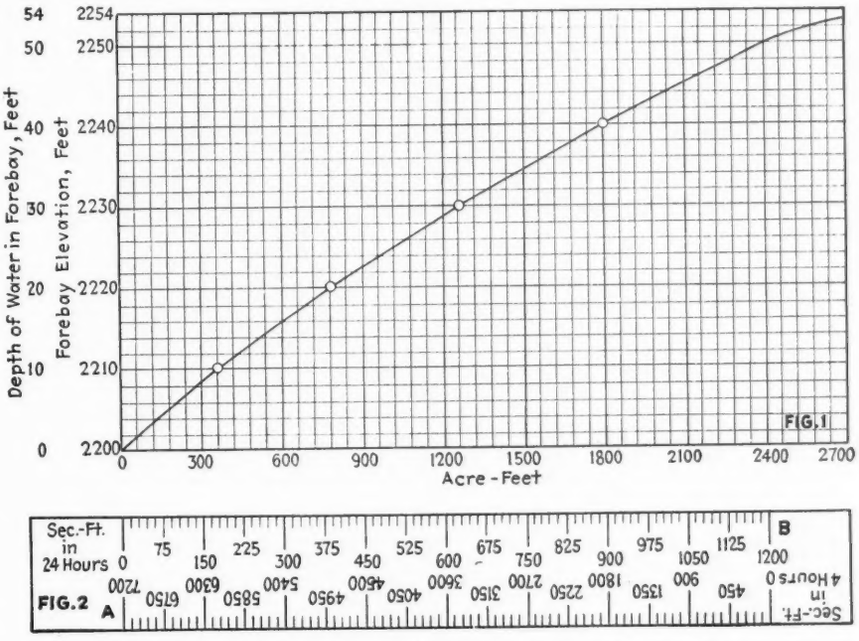


Fig. 1—Chart showing acre-feet available from the forebay

Fig. 2—Scale for converting acre-feet into second-feet

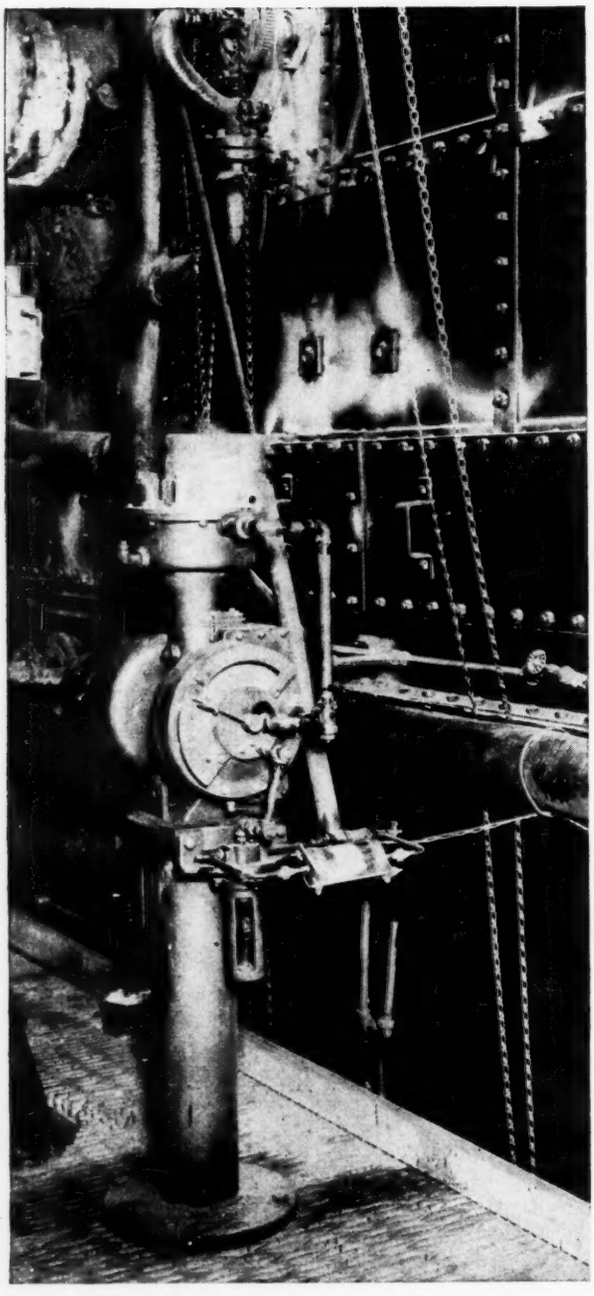
Hours	Spill Elev. at End of Each Hour, Ft.	Aver. Spill Elev. During Each Hour, Ft.	Aver. Spill During Each Hour, Sec.-Ft.
4th	1.00	0.875	350
3d	0.75	0.625	250
2d	0.50	0.375	150
1st	0.25	0.125	50
Total		2.000	800
Average		0.50 ft.	200

The average inflow is the sum of the water used in the plant, stored, and spilled, or 300+300+200=800 sec.-ft.

Assuming an initial reservoir elevation of 2,251, a final elevation of 2,250 and a draft of 400 sec.-ft. for a period of 4 hr., the inflow for a decreasing forebay elevation is computed thus: From the 4-hr. scale it will be found, as previously stated, that 300 sec.-ft. must flow to decrease the forebay elevation 1 ft. It has been shown that the average spillway discharge for a rise of 1 ft. is 200 sec.-ft., and this value can also be taken during the decrease. Therefore the flow to the power house from the water stored above the spillway elevation must be 300 — 200 = 100 sec.-ft. The power house draft is 400 sec.-ft., and the inflow 400 — 100 = 300 second-feet.

CO_2 Controls Combustion in Anheuser-Busch Plant

By A. B. STICKNEY
Fred Ophuls & Associates, Inc.



Fans are in aligned cases on opposite sides of pedestal. Bell chamber is on top

Direct control of combustion from the CO_2 percentage has long been a dream of power engineers. Equipment developed for this purpose at the Anheuser-Busch plant has been in operation for several months with entire satisfaction

IN THE new Anheuser-Busch power plant in St. Louis, described in the June 17, 1930, number of *Power*, the air flow through the furnaces is controlled entirely by the CO_2 in the flue gases. For a control of this kind to be satisfactory, it is necessary, first, that a fair sample be taken; second, that the time between sampling and correction be small; third, that the apparatus be sensitive enough to give an accurate setting; and, fourth, that it be reliable in operation. The development of the scheme and apparatus for this purpose, and its adaptation to existing conditions, involved a number of interesting solutions.

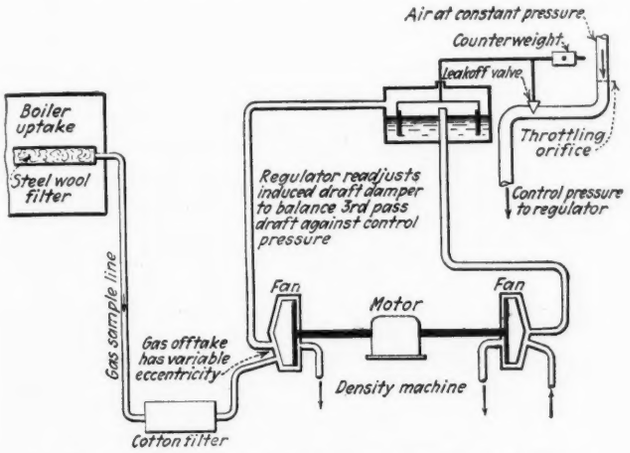
To get a fair sample, it should be taken as near the point to be controlled as possible. The exit of the combustion chamber is the point to be controlled, but, practically, it is impossible to take a representative sample directly from this point. The farther along in the path of the gases beyond this point a sample is taken, the greater its dilution from infiltration, and the less representative it becomes. However, with a tight boiler setting the leakage around the boiler itself is small. In the present case, it has proved satisfactory to take the sample from the uptake at a point just above the boiler.

Perhaps the most difficult problem to work out was the taking of a sample continuously. Due to the high fly-ash content, it is necessary to filter a great deal of very fine ash from the sample. This tends to stop up any sampling lines and rapidly clog any filter fine enough to remove it. Oil-washed grid piles and oil-washed steel wool were tried, both separately and together, and were supplemented by small cyclones which separated most of the ash before reaching the filter. But it was found impossible to make them work reliably for a long enough period to be practical from an operating standpoint. The final solution was to pass the gas, while it is still well above the dew point, through a tube about four feet long filled with steel wool. This filter is within the boiler uptake. It is supplemented by a filter at the machine consisting of a three-inch glass tube 8 in. long, filled with cotton. The sample reaches the cotton filter hot enough to allow filtration above the dew point, but not hot enough to damage the filter. The CO_2 machine is placed alongside of the boiler, near the sampling line.

Once having the sample, it is necessary to analyze it and readjust the air flow accordingly. The apparatus finally developed to do this is illustrated schematically in the accompanying diagram. Two blower-type fans are driven at the same speed, one in air and one in the filtered

gas sample, and both discharging to the atmosphere Due to the difference in the density of the gas in which the two fans work, different suctions are set up, and this difference is a measure of the CO_2 in the flue gases.

The gas takeoff is mounted eccentrically to the fan so that its radius may be varied. In this way identical suctions are set up in the two lines for a given CO_2. The two suctions operate on a bell, which is balanced by



Differential suction of fans operates control mechanisms

a lever over a fulcrum and which operates a leakoff valve. This varies the pressure in a control line running to the induced-draft damper regulator, which readjusts the damper to maintain the third-pass draft proportional to this control pressure. By varying the eccentricity of the gas takeoff the CO_2 which the apparatus controls may be varied.

This hook-up has worked out satisfactorily, and is in continuous use. Provided the filters are cleaned regularly, it is thoroughly reliable. The steel-wool filter can be cleaned when the boiler is being serviced and the cotton filter, which needs frequent renewal, is built with a cartridge which can be changed in a few minutes. It maintains the desired CO_2 within about ± one-fourth of 1 per cent, and the time lag in its operation is negligible.

▼

Scavenging Limitations of High-Speed Two-Cycle Diesels

By J. W. ANDERSON
National Transit Pump & Machinery Co.

THE TREND toward higher speeds for diesel engines brings in its wake many problems. Four-stroke-cycle engines have mechanical and combustion problems, and two-stroke-cycle engines have these and the scavenging problem as well. And the scavenging problem involves more than just merely sweeping the burned gases out of the cylinder and filling the cylinder with fresh air. It is important to retain as large a percentage of air in the cylinder as possible in order that the largest possible amount of fuel can be burned and thus the largest amount of power be obtained.

A simple method of making some comparisons in this respect follows a procedure developed some years ago and satisfactorily used for this sort of work. We know that volume divided by area gives velocity. Therefore, if we divide the cylinder volume by the mean area through the scavenging ports during the entire time that the scavenging ports are open, taking into account the total time that these ports are open, we shall have an expression for velocity. It will not be the true average velocity, because we have chosen arbitrary values for the volume and time for the process rather than the true values. But the true values are difficult to determine, and experience has shown that the simple, though arbitrary, method used is adequate for this purpose. The values obtained are employed in a comparative way only.

The cylinder volume is obtained by multiplying the cylinder area by the stroke. To get the port area, take rectangular cross-section paper and lay off crank angles in degrees horizontally and actual piston motion vertically. The resultant curve, Fig. 1, will be slightly different for various ratios of connecting-rod length to crank radius. Then from this curve calculate and plot another for the mean heights of port opening for each crank angle. In other words, this latter curve shows the average height of the port opening for the entire time the port is open plotted against the crank angle at which the piston uncovers the port or closes it on the other side of dead center. For example, if the port is uncovered at 130 deg. from head dead center the mean port height will be 10 per cent of the piston stroke. Then this mean height multiplied by the circumferential width of the ports will give the mean area. The time is calculated from the total angle of port opening and the engine revolutions. Of course care must be taken to use the same units throughout.

It should be pointed out that these calculations can just as well be made on the basis of the exhaust ports. It depends upon what the object of the comparison is

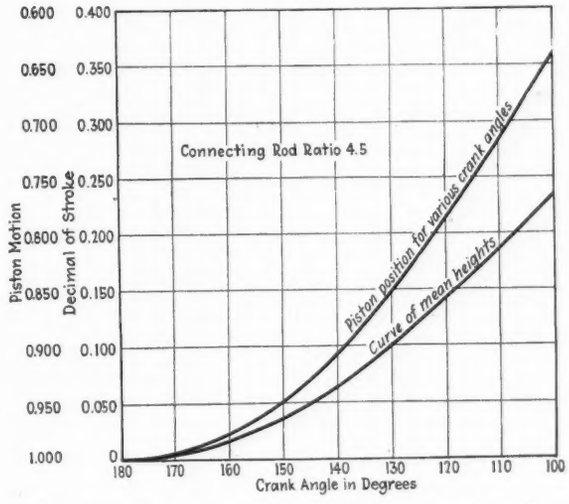


Fig. 1—Average port height for various crank angle uncoverage

and somewhat upon the system of ports employed. The method, in general, is equally applicable to scavenging, or exhaust, ports placed around the circumference or on one side only.

Using the exhaust ports as a basis, and feet-seconds as units of measurement, this velocity constant has been found to be in the vicinity of 70 in several engines with scavenging and exhaust ports opposite each other and where the scavenging pressure was two pounds or a little less at normal load and speed.

Now the higher the speed of the engine the higher the ports must be to maintain the same scavenging pressure, and this is, of course, very desirable to keep the

scavenging pumping losses at a minimum. But as the designer raises the ports the effective stroke of the engine is reduced, and thus there is less air in the cylinder to be compressed into the clearance volume for combustion. This assumes that the pressure in the cylinder when the scavenging ports close is always the same, and must hold true as long as the port sizes are deliberately increased proportionately to hold the same scavenging-receiver pressure. If less air is retained in the cylinder, then less fuel can be burned, and less power developed.

As an illustration, with an engine with 14-in. stroke for which calculations were recently made, the data shown in the tabulation were obtained.

R.p.m.	257	400	600	775
Piston speed, ft. per min.	600	935	1,400	1,800
Port height, per cent of stroke	20	27	34	41
Combustion chamber volume, per cent	7.2	6.6	5.9	5.3

The first two sets of figures are reasonable, but there is an appreciable loss of air available for combustion. The figures in the third column are not impossible, but the loss of air is serious. The values in the fourth column reach absurd proportions, yet such speeds of revolution and of piston speed are not out of the way for four-cycle engines. What can be done about it?

If designers raise the scavenging pressure or fit supercharging ports they increase the pumping losses. The proper course, then, is to adopt a port system that gives the most perfect scavenging with the lowest port height and the lowest scavenging pressure. The Junkers system and the modification as adopted by Burmeister & Wain have these advantages. But both of these types pay the price of additional mechanical complication.

In this connection it must not be overlooked that in existing commercial forms of engines neither the two-

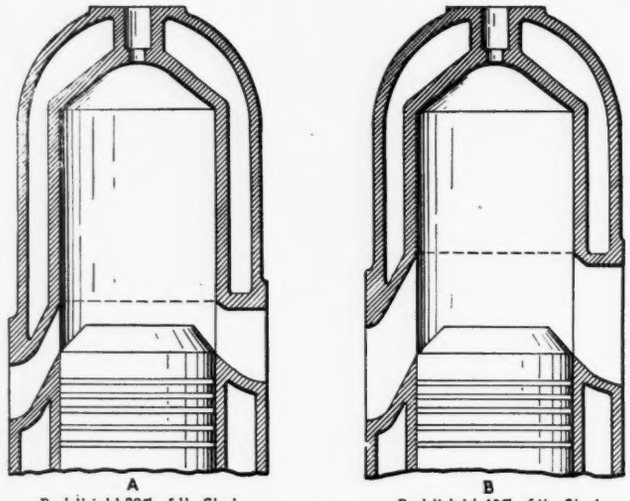
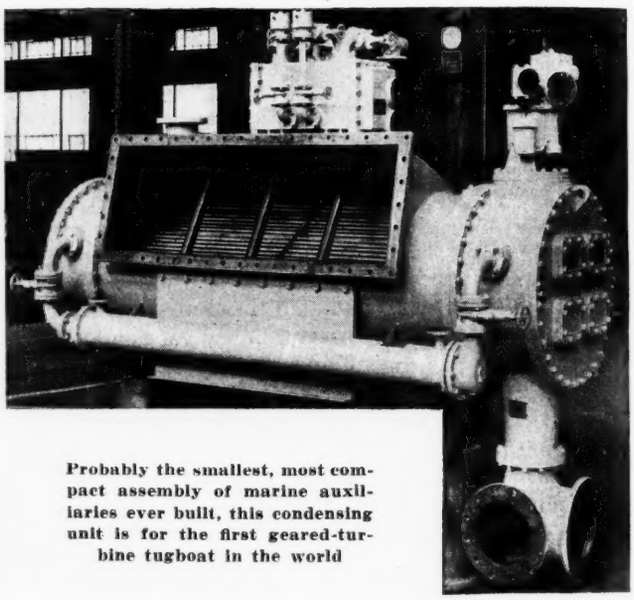


Fig. 2—Relative dimensions of a 20 per cent and a 40 per cent exhaust port height

nor the four-stroke-cycle engine effectively uses for combustion all the air there is available. Thus the two-stroke-cycle engine can afford to lose some of the air in the combustion space and still compete successfully. If, however, the commercial high-speed four-stroke-cycle engine that uses most of the air available is ever produced, the two-stroke-cycle engine will have some exceedingly difficult competition for the same class of service. The Junkers and similar systems will receive more attention, then, but the best solution or solutions to the problem can come only after much experimental and commercial experience.

New Self-Contained Marine Condensing Unit

THIS 1,020-sq. ft. condensing unit, designed and built at the South Philadelphia works of the Westinghouse Electric & Manufacturing Company, is probably the smallest, most compact, light-weight assembly of marine auxiliaries ever built. One foundation supports four pieces of apparatus: the main condenser, the circulating pump, the air ejector, and the oil cooler. The double-banked two-stage steam-jet air ejector is on top of the main condenser, and on the right-hand end built into the waterbox is the turbine-driven propeller-type circulating pump. Mounted on the side is the single-pass oil cooler which receives water from the main injection. The steel plate shown in front is one of two supports which form a



Probably the smallest, most compact assembly of marine auxiliaries ever built, this condensing unit is for the first geared-turbine tugboat in the world

foundation for the complete unit. The position of the exhaust opening and the use of flexible supporting plates make an expansion joint unnecessary.

This condenser will be part of the equipment for the first geared-turbine vessel on the Great Lakes.

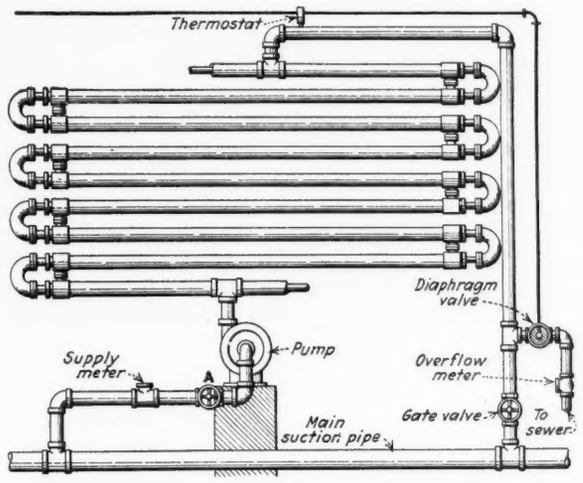
▼

ASH FUSION TEMPERATURE—The ash in coal consists principally of a mechanical mixture of varying percentages of silica (SiO_2), aluminum oxide (Al_2O_3), iron oxide (Fe_2O_3), calcium oxide (CaO) and sulphur oxide (SO_2), with smaller percentages of the oxides of magnesia, soda and potash. The chemical constituents of the ash vary not only in the same seam but in different parts of the same mine. Nothing definite is known as yet concerning the relations of coal type to chemical analysis of the ash, or to ash-fusion temperature, except that in a vague, general way the anthracites have high fusion temperatures (2,600 to 3,100 deg. F.); the Pennsylvania bituminous beds and similar coals have medium ash-fusion temperatures (2,200 to 2,600 deg. F.); and the Mid-Western coals have low fusion temperatures (1,900 to 2,200 deg. F.). In general, ash high in silica and alumina has a high fusing temperature, while ash containing an appreciable quantity of the basic oxides of iron, lime, etc., or of iron pyrites, has a low fusing temperature.

...RIGHT OUT OF THE PLANT...

Check Valve Stops Waste of Condensing Water

COOLING WATER for a double-pipe condenser attached to a refrigerating system came from the city main under a pressure of about 40 lb. The supply was taken through a branch running off from the main pipe, through which the house and boiler-feed pumps also were supplied. A centrifugal pump circulated the water through the coils of the condenser and back to the main suction line. Running off from the section of the circulating pipe leading back to the suction main was a branch to the sewer. In this branch was inserted a thermostatically operated diaphragm valve for controlling the overflow. When the



Water connections to double-pipe condenser

temperature of the circulating current issuing from the condenser became too high, the thermostat would act to open the diaphragm valve. By thus giving a portion of the water free escape, the flow through the condenser would be speeded up.

Although the object of the arrangement was to decrease the plant's water consumption, it was apparent from the beginning that a radical defect existed, for the meter in the waste pipe continually registered higher than the meter in the supply pipe. Investigation of the difficulty finally disclosed that the cause lay with the gate valve near the junction of the return pipe with the suction main. The excessive flow registered by the overflow meter was due to occasional throttling of the circulating current, as the inlet temperature would permit, by means of the valve *A*. When this was done the pressure from the street main would force the diaphragm valve open against the tension of the spring and permit of a considerable flow of water to the sewer. Removing the gate valve and inserting a swinging check valve in its place solved the difficulty. A. J. DIXON.

St. Louis, Mo.

Why the Ship's Turbine Would Carry Only Half Load

A UNITED STATES GOVERNMENT ship repair award to a certain yard included the repair of a steam-turbine-driven generating unit that was the source of supply for light and provided power for a large winch used to lay mines and for other work. The usual procedure, stripping the machine and obtaining the necessary replacement parts, was followed, and a service man was secured from the manufacturer to supervise the work. Everything was going fine, general overhauling was done and the new parts were fitted when received. These repair jobs are usually scheduled for so many days, with penalty for delays stated and enforced. In this case the penalty was $500 a day for each day over the time specified.

About three days before the whole job was winding up nicely on schedule, the turbine was finished and run, apparently functioning all right, when someone noted that only half load was available. It was thought, reasonably enough, that full load was required. It was found that there was not a normal full load available on the ship without the large winch or hoist, and the characteristics of the motor would not permit full current unless a capacity load was lifted. An artificial load was made by a liquid resistance, to equal full load, and the set was run up and loaded. To our surprise, the governor shut off and stopped the machine. Then the members of the crew informed us that it always did this; that every repair yard knew it, save ours. The engineer-commander, when asked about it, agreed that there was something radically wrong. But he insisted we had to fix it, and fix it right, reading to us from the specifications that not only was it to furnish full load, but 125 per cent load.

This was only two days before the time limit; there was no time to lose. The service men had taken the covers off everything and reported all in order, only the turbine would not work. Their superiors were appealed to, and gave us the information that it was an old machine (20 years), in fact so old that nobody knew anything about it, except perhaps someone in the factory. We went after the factory, and found there was such an individual, but he was an "official" now and would be playing golf tomorrow and could not be disturbed. Back we went to the highest of our own officials, who, in turn, got in touch with the "great" man, say Mr. X. He agreed to forego his golf game.

Mr. X was a man of years, a real mechanic who knew

turbines from away back, all the types his and other companies had made. The service department, of younger men, was naturally more familiar with later and more modern types. With Mr. X down to the ship, we started up the turbine—and got the same result. After a little inquiry and thought, he asked that the governor casing be removed so he could examine the mechanism. He did so. After going over it, he told us we had the piston valve in *upside down*. When this was changed the set was run up again to speed and it carried full load and even 25 per cent overload with no sign of trouble.

This experience indicates very clearly the need for care in marking parts of this kind when they are first removed from the turbine, particularly so where the part is symmetrical and will fit in either a right or wrong position. Marks to indicate the right position of a part, such as a governor valve, are seldom, if ever, made by the manufacturer, so must be taken care of by the purchaser.

Meriden, Conn. J. S. ISDALE.

"Why Air Agitation in Ice Cans?"

REFERRING to the editorial entitled "Why Air Agitation in Ice Cans?" in the March 17 number, and the comments thereon in the July 7 number, by W. F. Schaphorst, it would appear that Mr. Schaphorst is somewhat confused in his ideas as to the real function of air agitation of water in ice cans.

Pure water, that is, free from bacteria, will, of course, make pure ice, regardless of whether the water in the cans is agitated. On the other hand, if water delivered to the cans to be frozen contains harmful or dangerous bacteria the frozen product is also likely to be contaminated. Particularly is this true in the case of the typhus bacillus, which is not destroyed by freezing. Air agitation does not insure purity of the finished product.

The object of agitating the water in the cans is to liberate carbon dioxide, which, in turn, causes the carbonates to be precipitated during freezing. The carbonates move toward the center of the block of ice and are drawn off before the cake is entirely frozen. The void left in the block of ice by the pumping of the cores is filled with fresh water which is agitated until freezing is completed.

Most waters used for ice-making purposes contain carbonates of lime and magnesia, which in themselves are insoluble in water. In the presence of carbon dioxide, however, they become soluble by attaching to themselves the molecules of carbon dioxide.

Carbon dioxide becomes, in the language of the chemist, half bound to the carbonate molecules. As the crystals of ice are formed the half-bound molecules are freed and the carbonates of lime and magnesia contained in the small quantities of water which have crystallized are precipitated.

It is evident from the foregoing that the function of air agitation is primarily to make it possible to precipitate certain properties in the water and thus enable their removal by core pumping before the cake of ice is entirely frozen—not to purify the water, as indicated by Mr. Schaphorst.

Many of the ground waters used for ice making must be treated chemically, usually with lime, in order that the objectionable properties may be precipitated external to the freezing tank, thus permitting clear ice to be made.

The matter held in suspension in water to be frozen is purely a question of filtration; and certainly no progressive ice manufacturer would consider filling cans with water that contained matter in suspension or that was turbid.

Any pollution that finds its way into the ice cans from the tank top, as indicated by Mr. Schaphorst, is not eliminated by air agitation. There is no reason why cores could not be pumped in the case of the unagitated water as well as in the case of water that is agitated.

There are in existence many small ice plants in hotels where no attempt is made to agitate the water. Water for can filling is taken from the city mains through the house filters. In the majority of such plants the freezing tank temperature is carried fairly high, that is, 17 to 19 deg.; therefore, freezing takes place relatively slowly giving a good appearance to the finished product. Such ice has been found to be pure and entirely suitable for domestic use.

No one, of course, questions the fact that a better-looking block of ice may be produced by agitating the water during freezing. Also, it is well known that the public has been educated to look for and to expect clear ice. However, this does not mean that ice produced by the suggested non-agitating method is not pure and suitable for domestic use, especially where cores are pumped in the usual manner and where the usual method of water treatment is employed if the ground waters are high in soluble solids.

The statement that "the use of raw-water air agitation eliminates this solution and filth" (referring to dirt that finds its way into the ice cans from the top of the tank), is not in accordance with the facts. It is ridiculous, also, to suppose that air agitation will in itself remove or destroy harmful bacteria. If this were true, then methods of purifying city water would be much different than they are. C. T. BAKER.

Atlanta, Ga.

The Incubator Stoker or Caking Tipple for Handling the Low Volatile Fines

LOW-VOLATILE COAL is not always a smokeless fuel. It is only so to the degree that it will "stay put" as it is fired. In the progressive stage from coal to coke it holds its place among the elite of the heavier coke pieces only in inverse ratio to the amount of fines present, plus the rating and allied air blast.

Low-volatile fines are elusive as the vehicle for thermal values. They have been responsible for the loss of many economy tests against their freer, harder structure brothers from the high-volatile fields which laboratory tests have labeled inferior.

A cloud of low-volatile fines carried swiftly into the breeching with the blasts of high ratings may be several shades paler than 30 or 40 per cent volatile fines but this fly ash is a real B.t.u. loss, and, what is equally disturbing, dirtier than the floating smudge of high-volatile coals. Under heavy load conditions low-volatile, with a high percentage of fines, loses its status as a "clean-stack" coal.

There is one plant with which I am familiar where they actually reduced the stock emanations by changing from a friable, 20 per cent volatile coal to a high-volatile screened nut. Over a 2- or 3-in. blast the fines of the

low-volatile coal not only blew across, because they lacked the cohesive weight of the larger pieces, but also offered so much surface to distillation that heavy smoke resulted.

The foregoing is not news. Most operators in the low-volatile fields are aware of this condition and in some instances are removing a percentage of the fine coal. The answer, however, seems to lie in another direction: Either an incubator stoker where the little particles will be carefully herded in a mass until they attain the stature of their brother lumps, or in a treatment at the mines which will make them non-existent. They must be held in the fuel bed, for they are responsible for the greater proportion of the B.t.u. content of the coal. With the trend to mechanical cleaning the fines are increasing. Screening out this pure coal does not seem to be the logical answer, for there is always the problem of a lopsided demand as between the sizes and higher mining costs due to unbalanced markets.

In some low-volatile coals the percentage of fines is so great that it is impossible to screen coarse enough to yield an easy-flowing slack. Coarser screening would rob the mine run and make it difficult to market that grade as well as the slack at the prevailing prices. There is a degradation in the coarse coal, and wind-blown and leakage losses in the fines or slack. In storage there may be arching of the fine coal, which affects, seriously, the flow to the stokers or mills.

To give a general idea of the heat loss due to the presence of fines, take a coal of 14,600 B.t.u. per pound and assume that it contains 5 per cent fines. Subtracting the fuel value of the fines, we find there are available 13,870 B.t.u. It has been determined from the examination of the flue gases that 18 per cent of this apparent B.t.u. loss is utilized, so this addition of 130 thermal units gives us 14,000 B.t.u. as the potential value of the coal, and not 14,600 as the laboratory reveals. This loss is proportional according to the load; but even with low ratings in a hand-fired boiler the fines have a smothering effect, which means open doors, chilled gases and low efficiencies.

The solution may lie at the tipple. In view of the developments in briquette binders it is possible that some plan may be reached whereby the fines are separated and roughly caked; these cakes may then be broken up and added to the lumps to produce a coarse run-of-mine. Even with the degradation resulting from shipment and further handling at destination, this lumping of the fines would raise the thermal value of the coal to those consumers who are now paying premium prices for a fuel which substitutes lump for calorific value.

The ideal condition would be the shipment of run-of-mine coal with no thought on the part of the producer to the percentage of fines. The lumps cushioned in the fines would reach destination with little degradation. The coal would be screened at the boiler plant, the fines moving to the powder bunkers and the lump to the stoker bunkers. It would be a far-sighted move on the part of the consumer so equipped, for he could quickly solve a serious mine problem and remove his fuel from the economic uncertainties which must follow unbalanced production. If both the powdered coal and stoker-equipped furnaces are to develop on sound lines the installation of one method should not penalize the other and acquire a false value through the medium of a coal problem. A later solution of that problem might not affect its efficiency, but could easily scrap it from the angle of economy.

C. PRITCHARD.

Albany, N. Y.

Repairing Brick Chimneys

IN THE June 2 number of *Power* a practical method of repairing a chimney was described. The design of the steel reinforcing used is in my opinion excellent and undoubtedly has made the chimney secure. The report is also interesting inasmuch as the repair presumably was carried out by unskilled men and that the equipment had to be manufactured for this job and will be of little use for other purposes.

It may not be without interest to know that concerns making a specialty of building chimneys usually have an efficiently equipped repair department. In general the method of procedure in this particular case would have been as follows:

The chimney would have been scaled from the outside; and it would not have been necessary to take it out of operation. A series of ladders each about 10 ft. in length would have been spiked to the chimney and the top of the chimney could have been reached in two or three hours.

If the defect was located somewhere between the bottom of the chimney and the top, ladders would have extended only to the location of the cracks and it would not have been necessary to reach the top of the chimney at all. Either an iron band or a steel cable with turnbuckles would have been placed around the chimney just below the crack. Into this band or cable triangular brackets would have been hooked; boards would then have been placed across to form a working platform. The stage then would have been set to place the reinforcing and seal the cracks. This temporary scaffold can be removed in a few hours. The illustration shows repairmen at work at the top of a chimney and the character of the rigging they are using.

Temporary scaffold is supported from band around chimney

P. H. WALKER, *President,*

New York, N. Y. American Chimney Corporation.

From Among Readers' Problems

Conducted by
L. H. MORRISON

SIZE OF BOILER BLOWDOWN TANK—*We have a 5-ft. diameter × 20-ft. long drum which we wish to use as a blowdown tank for four 250-hp. boilers. Is the tank large enough? What outlets should be provided?* A.R.C.

The tank is of ample size, but in selecting a location precaution should be taken that no damage will be done in the event of rupture from water-hammer or excessive pressure. The tank should have a manhole in the top, with a light loose cover on the outside. For the escape of vapor, place in the top of the tank an open vent at least twice the diameter of the inlet pipe. Connect the inlet in or near the top of the tank and have an outlet in the bottom for cleaning. For the discharge of the water from the tank, place an outlet in one of the heads of the tank 18 or 20 in. above the bottom, with inside connection dropped within 6 in. of the bottom so the outlet may be kept sealed.

COAL CONSUMPTION FOR OPERATION OF STEAM SETS — *Each of our six boilers is equipped with six ⅛-in. steam jets above the fire, steam being supplied at 120 lb. What quantity of coal is required to make the steam used by these nozzles?* R.C.S.

Assuming that the pressure of 120 lb. per square inch is maintained in the nozzle, the quantity of steam discharged by each ⅛-in. diameter aperture may be found by Napier's approximate formula. *Flow in pounds per second* = *Absolute pressure* × *area in square inches* ÷ 70

As each ⅛-in. diameter aperture would have an area of 0.01227 sq.in., and the pressure would be 120 + 15 = 135 lb. abs., the quantity of steam discharged by the six nozzles on each boiler would be 6 × 135 × 0.01227 ÷ 70 = 0.142 lb. of steam per second or 511 lb. of steam per hour. The quantity of coal then required per hour per boiler, assuming each boiler evaporates 8 lb. of water per pound of coal, would be 511 ÷ 8 = about 64 lb. an hour, or 384 lb. for the six boilers.

PRIMING OF BOILER — *We are having considerable trouble from foaming and priming in our boilers. How can this be prevented.* L.C.

A boiler is said to prime when the water is carried up and over with the steam as it is discharged from the boiler. Priming occurs when the water surface is so close to the steam outlet that particles of water projected upward in the steam space, by ebullition of water, or bubbles in the steam space due to foaming, are swept along with the steam, as it leaves the boiler. Remedies for priming due to ebuillition are to have a larger disengaging surface by carrying a lower water level. The activity of ebuillition can be retarded temporarily by checking the fires or feeding more rapidly. A permanent remedy is to carry lower water level or provide a dry pipe or other form of separator or purifier within the boiler through which the steam must pass on leaving the drum.

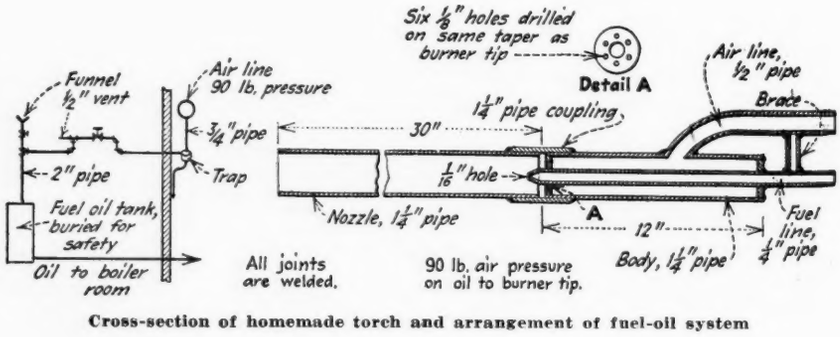
Foaming is caused by any impurities either dissolved in the water or suspended in it, which retard or interfere with the free escape of steam from the water to the steam space. A collection of scum on the water surface is also a common cause of foaming. Such a scum is generally caused by the presence of oil, vegetable matter or sewage. If the water contains an alkali any animal or vegetable oil that may find its way into the boiler is changed into soap, which forms suds and causes foaming. Foaming may also be caused by concentration of certain salts, as from use of soda ash or other boiler compounds. Foaming can be reduced, and in most cases prevented, by blowing down regularly and sufficiently, by cleaning the boiler regularly and by not forcing the boiler too much above its rated capacity.

PREVIOUS QUESTION
DISCUSSED BY READERS

THE QUESTION

THE METHOD of firing our boilers was recently changed to pulverized fuel, but no provision was made for igniting the coal. We wish now to install a standard type of oil ignition torch and desire advice as to its best location with respect to the burners. The burners are of the horizontal turbulent type located about 5 ft. above the furnace floor on either side of the centerline. C.J.C.

WE HAVE a 19,500 sq.ft. boiler with a two-unit mill installation, each mill having a capacity of 7,500 lb. an hour. There are two horizontal turbulent-type burners to each mill, four burners in all. We find that the best position for the torch is in the side of the boiler at right angles to the burners, so placed that the nozzle of the torch is about 3 ft. further in the boiler than the burners and about 2 ft. higher than the center of the burners. By placing the torch in this position it is easily possible to light all four burners with one torch, also, the flame from the torch comes into intimate contact with the coal, effecting positive ignition. To put the torch lower than the burner, or closer to it, is to increase the danger of a flareback. The coal



Cross-section of homemade torch and arrangement of fuel-oil system

should ignite away from the burner and burn back to it.

Speaking of torches, I should like to describe the torch we are using. We formerly had a makeshift torch which was very unsatisfactory. The torch, illustrated, was made of materials which are found around any plant. It has proved satisfactory, cutting the fuel bill practically in half. A length of ¼-in. pipe, threaded at one end and drawn to a tip at the other is used for the oil nozzle, a 1/16-in. hole being drilled through the tip. The air chamber has a plate ¼-in. thick welded in place as shown in the illustration. The air line is a bent piece of ½-in. pipe welded to the air chamber and threaded on the open end for an air hose connection. A 30-in. length of 1¼-in. pipe serving as a mixing tube is connected to the air chamber with a coupling. Oil is forced to the burner tip by putting air pressure on the fuel storage tank. If not convenient to put air pressure on the oil tank, oil can be fed to the burner by gravity.

Two torches may be used, one on each side of the boiler, although one will light off a four-burner boiler. A torch permanently fixed in place is not advisable, as the tips are burnt off and they frequently get out of order, necessiating frequent repairs. We have a bracket on the side of each boiler where the torch is hung, the oil and air hoses being always connected to the torch.

Venice, Ill. J. G. BIRDER.

IN VIEW of the meager information given about the coal burners, two solutions will be necessary. If the burners are provided with an opening through the center through which a standard oil torch can be introduced an extremely satisfactory installation may be made. Each coal burner may be fitted with an oil burner long enough to reach through it. The oil burner tip is placed about 1 in. beyond the end of the coal burner. These torches will be supplied with oil by a pump and storage tank placed outside the boiler room, and will be connected to the pipe line with armored hose so that they may be slipped back inside the burner when not in use.

With the proper size of tips on the torches, this system may be designed to carry a large part of the boiler load in the event of shutdown of the coal burning equipment. For lighting off a fire, a small tip is used which requires but a small amount of oil. This system puts the ignition flame in exactly the right place for lighting, as it completely covers the cone of coal entering the furnace. An installation of this kind is not necessarily expensive, and it is excellent insurance against shutdown. A light fuel oil which does not require heating is burned.

If the coal burners are not adaptable to this system, or the initial outlay is excessive, a portable torch may be used. It consists of a burner similar to, but smaller than, those used on a stationary installation connected through an armored hose to a portable tank of 15 or 20 gal. capacity. The tank is connected to a compressed air supply of 50 to 100 lb. pressure. The torch is introduced into the furnace, preferably below the burner and as near parallel to it as possible, and the oil adjusted to give a "fat" flame.

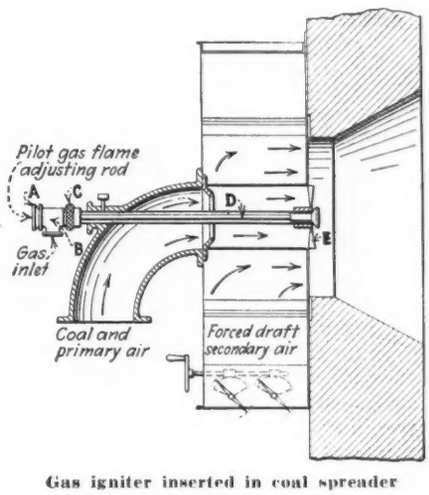
In either case the oil is ignited with a kerosene soaked asbestos torch lighted with a match. J. C. PORTER.

Saltville, Va.

IN MANY pulverized-coal installation, except where a burner for pulverized-coal in combination with oil or natural gas is used, the usual methods of igniting the pulverized fuel are more or less hazardous, owning to a possibility of retarded ignition and blowback. To preclude this occurrence and to provide a safe and convenient method of igniting pulverized fuel where gas is available, the igniter illustrated was developed by the writer.

Our plant is equipped with horizontal turbulent burners located at the operating floor level and 8 ft. above the furnace floor. The igniter, which consists, essentially, of five parts, as indicated by *A*, *B*, *C*, *D* and *E*, is shown incorporated in a Riley flare-type burner arranged for horizontal firing. In the particular burner illustrated the gas tube is inserted in the center of the coal-spreader pipe and the gas tip or spreader *E* is made adjustable by means of a central rod *D* and knurled nut *A*, the spreader being adjusted to produce a flame of sufficient area to completely cover the end of the coal discharge pipe. The knurled nut *C* is used to adjust the fuel spreader and flame requirements of the pulverized-coal burner.

When the coal has become properly ignited the gas is shut off and the gas spreader *E* is drawn closed. The gas connection to the igniter from the main gas heater is made by a flexible armor-clad hose, at the tee *B* attached to the end of the coal-spreader adjusting pipe, as shown. In connection with our gas-lighting system we have a gas compressor capable of delivering up to 1,200 cu.ft. per hour at ½ lb. pressure. This compressor delivers the gas to a main header from which the flexible armorclad hose connection is made to each furnace.



Gas igniter inserted in coal spreader adjusting pipe

P. DIAS, *Plant Engineer*,
Essex County Hall of Records.
Newark, N. J.

THE PORTABLE-TYPE kerosene ignition burner would seem to be the most convenient and economical, provided conditions are such that it can be used.

This type of torch is compact and easily portable. It is equipped with a nozzle which can be inserted inside the burner, the flame propagating into the center of the powered-fuel discharge. There being less turbulence at the center of the burner discharge, this is the ideal place to start the ignition.

Compressed air is required to operate the torch, and the flame is easily adjustable. I have had experience with this type of torch and have found it very satisfactory. It has the advantages of a low initial cost and economical operation and can be used in any location where compressed air is available. When not in use it is entirely out of the operator's way. RALPH RAINEY.

Albuquerque, N. M.

A Question for Our Readers

WE OPERATE a 1,000-kw. turbine with steam at 200 lb. and 100 deg. superheat and exhausting to a 2,750-sq.ft. two-pass condenser at 28 in. vacuum. It has been suggested that during the winter months we operate at 17 in. back pressure and use the hot circulating water in our hot-water heating system. Can the turbine and condenser be operated at these conditions, and what will be the approximate capacity of the unit?

Suitable answers from readers will be paid for[1] and published in the Sept. 15 number.

[1]As an alternative to cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired):

Morrison's *American Diesel Engines*; Walker and Crocker's *Piping Handbook*; Norris and Therkeisen's *Heat Power*; Emswiler's *Thermodynamics*; Church's *Steam Turbines*; Uehling's *Heat Loss Analysis*; Croft's *Steam Power Plant Auxiliaries and Accessories*; Powell's *Boiler Feed Water Purification*; Osborne's *Power Plant Lubrication*; Moyer and Fritz' *Refrigeration*; Rietschel-Brabbee's *Heating and Ventilation*; Annett's *Electric Elevators*.

The Power Problem of the Smaller Plant

From a paper by

ELY C. HUTCHINSON

Before the Smaller Industries Conference at Lake George, N. Y., Aug. 11, 1931

ALL INDUSTRIES, large or small, require power in one or more of its numerous forms for the manufacture of their products. It should be obvious, therefore, that, large or small, all industries should regard power as one of the units entering into the cost of manufacture.

In general, large users of power conduct their manufacturing businesses on a scale which permits them to maintain an engineering staff with the express duty, among others, of analyzing, comparing and otherwise studying their power problem. These large plants are accustomed to keep their records in usable form so they may be clear, not only to themselves, but understandable by, and comparable with, others.

The power utilities, with which, for the purpose of this paper, are grouped the large industrials using power, have by their very nature found it to their great advantage to make clear records and provide for their wide distribution and means for discussing mutual problems in open forum. It has long been a lamentable fact that none of these advantages has been available to the smaller industries, despite the fact that their number greatly exceeds those in the larger industrial group and they occupy a position of great importance in the affairs of the nation.

An analysis of industrial power distribution as compiled by the United States Census of Manufacturers, in 1927, lists a total of 174,118 manufacturing plants having a total installed capacity of 38,825,681 hp., approximately half of which is purchased from utilities. For convenience, these totals have been divided into four groups as follows:

Group 1 consists of all plants having an annual production valued at $5,000 to $20,000. In it there are 51,974 plants using a total of 442,588 hp., or an average rated capacity per plant of 8.5 hp. It should be obvious that wherever possible manufacturers in this power group should purchase their power.

Group 2 contains 63,988 plans with an annual production valued at $20,000 to $100,000, representing a capacity of 1,987,850 hp. This is an average rated capacity per plant of 31 horsepower.

Industry in general should be "power wise." None can afford to be complacent upon the subject of power any more than would any executive worthy of the name be doing his duty by failing to keep up to the minute and thoroughly abreast of all the improvements and market conditions affecting the manufacturing cost and distribution of his product. This wisdom must not cease abruptly the moment one is beyond the power house door. It must extend into the factory proper and to the power services therein. It is just as important to use power efficiently as to generate it

Group 3 contains 39,264 plans and has an annual production of $100,000 to $500,000. Its total horsepower capacity is 5,901,579, or an average of 150 hp. rated capacity per plant.

Group 4 contains 18,892 plans with an annual production valued at $500,000 and over. Its power consumption is 30,493,664 hp., or an average capacity per plant of 1,614 hp.

In these last three groups are industrial plants which purchase all their power, make it, or make or purchase part of their power, or actually make more power than they need and sell some back to the public utility.

The conclusion as to whether power should be made or purchased by an industry should not be settled by approximation or upon personal opinion. There is a very clean cut and definite answer for each and every case. Simply because a friend in the same business in some other town, or a neighbor, found it advisable to generate his own power, or not to, is not a sufficient reason for any individual to do likewise. Unfortunately, too much of this sort of thinking has been practiced in the past.

Whereas in times of prosperity, during which the margin between manufacturing cost and sales price was ample to absorb the cost of such errors, it is needless to point out that today it is only the manufacturer who has lifted these extra cost burdens from his shoulders, or is taking immediate steps to do so, who is at all ready to meet the changed conditions.

The manufacturing plant which is already making its own power has one problem, and the one purchasing power at present, but considering the installation of a plant for its generation, has another. Let us consider the first.

A recent tour among small industrial plants in several cities disclosed to me an astonishing and almost abysmal lack of appreciation of the part that power plays in the manufacture of their products. This was, of course, not so in every case. There were outstanding examples—in fact, model plants in a few instances; but, by and large, there was a notable lack of understanding of the power problem.

The idea of regarding the power house itself as a unit which can and should be operated with as much regard for the economies and the saving of dollars as the business executive proudly points to in the rest of his organization is frequently lost sight of entirely. Thinking in percentages of power cost to total cost of production quickly leads to a false paradise. The system should be wiped out and executives should think in terms of the dollars saved.

There are numerous other fallacies bearing upon this same question of saving the power dollar. One operator proudly pointed to the fact that, since his equipment was 50 years old and was last rebuilt 30 years ago, and long since amortized, his power was costing him little or nothing. To this point of view one may direct the very pertinent question "What price obsolescence?" In other words, regardless of when the equipment of a power plant may have been completely depreciated, how long dare one continue to use old-fashioned machinery in the face of the increased efficiency and dollars saved by the use of modern equipment?

Another of the bottomless wells for the sinking of power dollars is the indiscriminate purchase of second-hand power machinery. The result, more frequently than not, is a mismatched agglomeration of parts which probably

could not have been better selected had it been the purpose to find means to burn the greatest amount of coal and establish a never-ending regimen of maintenance and replacement.

Now, this is not to say that second-hand or used equipment is not all right in its place, for it is. The selection of all equipment, second-hand or otherwise, should, however, always be made under expert advice and counsel.

At this point I should like to say a word about receiving the counsel of sales engineers and consulting engineers. Because, in most cases, sales engineering advice is offered free of charge, there is a temptation to accept it and build to it. With no disrespect to the sales engineer intended, I must point out that only in rare cases will the sales engineer be found to recommend against his own equipment and in favor of some other which for some reason might be better in special cases. This is to be expected.

The independent consulting engineer, even though he must be paid a legitimate fee for his services, will, in most cases, save many times his cost in plant operating results.

As a rule, how many executives in the smaller industries pay any attention or give any thought to the number of savable dollars in the coal pile? In the selection of a proper coal and the determination of the best method for burning it lies one of the most fruitful sources for economy. In turn, it is directly related to the proper proportioning of the boiler load and rating. A modern boiler will generally offer opportunity for the use of a much greater range of selection of coal than the older types. This means a greater opportunity to select a fuel in which the combination of delivered cost and steaming quality will result in the greatest dollar economy.

While much of the foregoing applies with particular emphasis to the possible economies of power generation at plants already installed, it nevertheless applies with equal force to any industrial power plant, old or new.

Purchased versus Generated Power

Consider those manufacturing companies which may be contemplating the generation of their own power. A change from a present state, under which it is assumed power for the factory is purchased from some near-by source, to one in which it is proposed that the manufacturer supply his own power needs, should be made only after a careful engineering and economic analysis by a competent consulting engineer experienced in problems of a similar nature.

If purchasing energy at present, it is conceivable that the factory power bill may be greatly reduced by a regrouping of the electrical motors into circuits which will balance the load to better advantage.

A schedule may be established for the starting up, and even the periods of use, for certain of the large motors or groups of them, to reduce greatly the maximum demand for power and thereby effect a sufficient saving in the power bill to make one's own power installation look considerably less attractive. An examination of available rate schedules issued by the power company and an analysis of operating requirements and power needs may prove the solution of such a case.

Where Power Is a Byproduct

On the other hand, there are numerous instances where the combined requirements for heating, process steam and power are such as will show splendid returns upon the money invested, as the power may then actually be regarded as a byproduct to other necessary services. Numerous effective combinations of this kind have been thought out and put into satisfactory service.

Improvement of power factor in the plant is just as important to the man making his own power as to the one who purchases it.

Smoke abatement should also be considered, as it is evident that in the not-distant future all those operating their own heating plants or generating their own power will be expected to do so without unduly contaminating the atmosphere. Although smoke ordinances in some countries are more than 60 years old and some have existed in this country for close to 50 years, it is only during the past year and a half or two that the people of our country have assumed a militant determination to breathe clean air. At present there are in the United States something like 150 smoke-abatement ordinances. Of these probably not more than a quarter are used for actively attacking the problem of smoke abatement, but it is certain that more are going to be.

If the plant is an old one, in which the furnace volume never was and can not now be changed sufficiently to accomplish the practically smokeless burning the public is coming to demand, there are inexpensive and practical expedients the smoke inspector can suggest. But immediate consideration should be given to the savings possible in the replacement of obsolete equipment. This should be done, not by rushing to the nearest machinery house, but by careful consideration and under the direction of an adviser experienced in power plant design.

Efforts are being made by manufacturers to establish minimum setting heights for power and heating boilers and their furnace equipment, and it is believed that before long the settlement of these and other technical matters dealing with the construction of the modern power house, small or large, will automatically assure the owner of freedom from conflict with smoke ordinances.

Altogether, smoke ordinances and smoke inspectors should not be looked upon as impediments to power production, but as the pioneers of a power house technique which to date has in practically all cases meant improvement of operation and a saving of money most pleasing to the owners. With this background they are far more to be welcomed than feared.

The public utilities and the larger industries have long recognized the value of records and the immense advantage to all from the collection and interchange of statistical information. The smaller industries, on the other hand, have had none of the benefits that should come to them from collective thinking; so far it has been impossible to secure power information and statistics from them in suitable form or with sufficient background to give the feeling of reliability.

I hope that from this meeting there will come an organization and community of interests through which it will be possible for those who have the welfare of small industries at heart, to secure a reliable picture of the group, to discover their trends, isolate the tender spots and discover means for giving them the greatest possible economic assistance. The small industries have never had this because until now it has never been possible to bring them together into a group where the common problems could be discussed.

Developed Water Power Doubles in Ten Years

The capacity of the waterwheels in the constructed plants of the world, according to estimates made by the United States Geological Survey, was 23,000,000 hp. in 1920, 29,000,000 hp. at the end of 1923, 33,000,000 hp. at the end of 1926, and 46,000,000 hp. at the end of 1930, an increase of 100 per cent in ten years. The increase during the last four years in Europe has slightly exceeded that in North America. Outside of the United States, the greatest increases in constructed plants have been in Italy, Japan, Canada, Germany, Switzerland, Austria, and Sweden.

Estimates of potential water power are based on ordinary low water and an efficiency of 70 per cent in the plants. The installed capacity of machinery at constructed plants averages two to three times the potential power under conditions of low flow, and this accounts for the fact that in some countries the installed capacity equals or exceeds the estimated potential power.

Power Commission Starts Study of Holding Companies

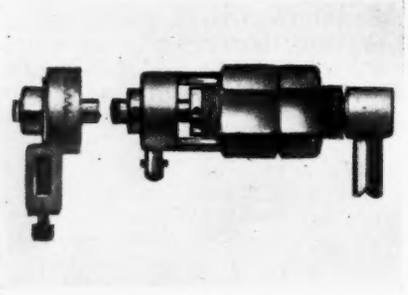
A questionnaire soon will be sent out by the Federal Power Commission to all of its licensees in connection with Dr. Walter M. W. Splawn's study of the holding company situation. By the time Congress convenes in December the members of the commission hope to be in the position to reply authoritatively to any inquiry which they may receive as to the control which holding companies exercise over licensees and the benefits which flow from the holding company plan of organization.

WHAT'S NEW IN PLANT EQUIPMENT

Ball-Bearing Stuffing Box

STANDARDIZATION on a new type of ball-bearing stuffing box is announced by the Fisher Governor Company, Marshalltown, Iowa. This new box is now furnished on all float cages and rotary lever valves manufactured by the company.

Stainless steel is used in the stem, nut and body of the stuffing box, and the steel ball bearings are assembled in the ball bearing unit, which is sealed and kept lubricated by a greasing connection. Combination radial-and-thrust ball bearings offer a good support for the float stem, reducing side throw or motion to a minimum. Positive liquid seal in the lantern ring, which is between two halves of packing, eliminates the possibility of air's being drawn into the system when it is used for vacuum service. By changing to a screw plunger greasing fitting, the stuffing box can be converted to a lubricated unit, allowing a suitable grease lubricant to be supplied to the lantern ring.



Assembly of ball-bearing stuffing box

Balanced Hydraulic Relief Valve

INSTEAD of the customary spring-loaded construction, the hydraulic relief valve recently announced by Vickers, Inc., 7760 Dubois St., Detroit, Mich., is operated by a piston that is in hydraulic balance regardless of the initial oil pressure and the pressure for which the valve is set.

Another advantage is that it is installed directly in the line and in any position, thus eliminating the customary tee and giving a neater and more compact installation. Working parts are of alloy steel hardened and ground to close limits.

A hydrocone-shaped valve prevents wire-drawing and eliminates oil foaming, and the valve is said to be non-surging. Turning an adjusting screw will vary the pressure from one extreme to the other.

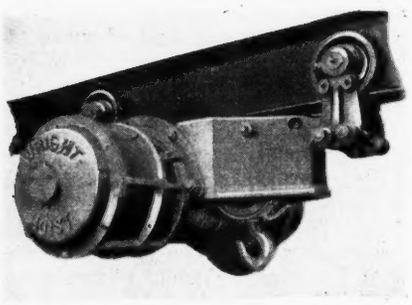
The relief valve is made in two sizes —for $\frac{3}{4}$-in. and $1\frac{1}{4}$-in. pipe connections. Their capacities are 0 to 15 g.p.m. and 10 to 40 g.p.m. respectively. The pressure range for both is from 0 to 2,000 pounds.

Vickers hydraulic relief valve

Electric Hoist for Minimum Headroom

TYPE WH electric hoist, illustrated, is designed for installations where headroom is limited. With this hoist the minimum distance from the bottom of the I-beam to the hook on the $\frac{1}{2}$-ton unit is only 11 in., and on the 1-ton hoist only 13 inches.

In other respects Type WH is similar to the Wright standard electric hoists. It is furnished with either push-button or pendant rope control, true-lay preformed cable, safety-type limit switch, safety-type load block and positive mechanical brake, by the Wright Manufacturing Company, Bridgeport, Conn.



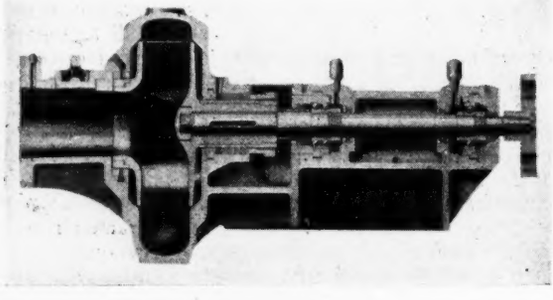
Type WH electric hoist

Centrifugal Pump for Liquids Carrying Solids

DESIGNED particularly for handling sewage, paper pulp and similar liquids, the "Clogless" pump developed by the De Laval Steam Turbine Company, Trenton, N. J., has a horizontally split casing, with the discharge connection in the lower half, or casing proper. A large handhole on the cover half of the suction nozzle provides quick access to the suction side of the impeller for inspection and cleaning. The suction nozzle is designed for a large suction pipe, insuring low pipe velocities and low total suction head. The pump volute or body is overhung, making the piping connections easily accessible.

The passages through the impeller are extra wide, both between the side plates and between the vanes. Ordinarily only two vanes are used. Where the pump capacity or the nature of the liquid permits, the number of impeller blades is increased to three or four, permitting of higher speed.

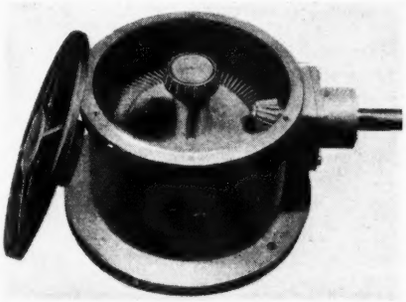
At the joint between the impeller and casing the impeller is protected by a bronze ring, while the casing is protected by a stationary bronze ring seated in recesses formed in the casing and casing cover. A circumferential slot in the stationary ring communicates with an opening through the casing cover to



De Laval "Clogless" centrifugal pump for handling material-laden liquids

provide for sealing with clear water under a pressure slightly higher than that generated by the pump. This prevents liquid and abrasive matter handled by the pump from entering between the rings.

In order to avoid too great overhang of the shaft, the stuffing box is located over the impeller hub, which is protected by a renewable bronze sleeve. A tapped opening in the casing cover provides for the introduction of clear sealing water at a pressure slightly higher than that of the pump.



Speed reducer with coverplate removed

Vertical Spiral Bevel Gear Speed Reducer

IN THE vertical spiral bevel type speed reducer illustrated, put out by D. O. James Manufacturing Company, 1114 West Monroe St., Chicago, Ill., the gears are made of chrome nickel of spiral bevel type with improved tooth form, which is said to provide more teeth in constant contact and a greater tooth bearing or pressure area in each tooth of given size. Roller bearings are provided on both drive and driven shafts.

Where large ratios of reduction are required this type of reducer is made integral with a planetary reduction unit so that all ratios from 8 to 1 to 1,600 to 1 are available. They are made in sizes from ½ to 100 horsepower.

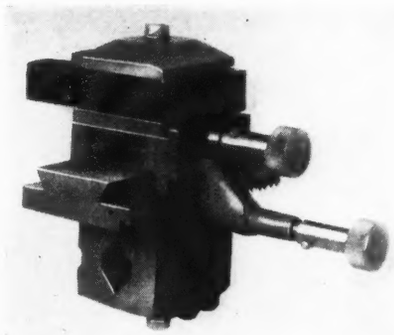
Fan Wheels in Seven Diameters and Four Widths

FAN WHEELS with back-plate construction (Type HV) are now being offered in seven diameter sizes and in four widths, one-third, one-half, two-thirds and full, by the Clarage Fan Company, Kalamazoo, Mich. The wheel consists of a large number of shallow steel blades anchored to the back plate and inlet rim. The back plate is rib stamped and riveted to the hub, which may be internal or external, as shown in the illustration.

Full-width wheels in the larger sizes can be furnished with tie rod braces connecting the back plate and inlet rim, and for extremely high speeds a peripheral rod bracing in addition to the tie rod braces can be furnished. Two types of fan assemblies are also available. One consists of a Type HV fan wheel, housing inlet ring and inlet screen, and the other a complete fan with support for mounting the motor. Pulley driven units can also be furnished.

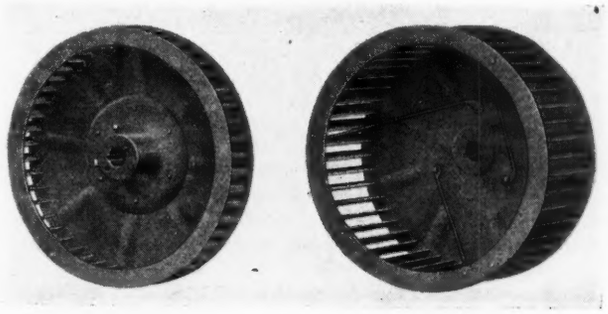
Small Commutator and Slip-Ring Grinder

THE "Midget" grinder illustrated is designed especially for use on smaller commutators having a face width of 8 in. or less, as well as medium-sized slip rings. It is adapted to brush arms not



"Midget" model commutator grinder

sturdy enough to accommodate either the "Ideal" or "Perfect" grinders (described in the June 23 number), as the weight and size has been kept down to a minimum. It is especially suitable for use in close quarters where the commutator or ring is not very accessible. The "Midget" grinder is practically a duplicate of the "Ideal" grinder put out by the same manufacturer, the Ideal Commutator Dresser Company, Sycamore, Ill.



One-third width fan with internal hub and full-width fan with external hub

Welding elbows of wrought iron

Wrought-Iron Welding Elbows

A JOINT ANNOUNCEMENT is made by the Locomotive Terminal Improvement Company, Chicago, Ill., and the A. M. Byers Company, Pittsburgh, Pa., of a line of wrought-iron welding elbows, known as "Weldells," in sizes from 2 to 12 in. The elbows are manufactured with the same radius and center-to-face measurements as standard radius fittings. In the forging, a tangent is formed on each end, making the elbows interchangeable with standard fittings, and the ends are beveled 45 deg. for welding. Stock sizes include both standard and light-weight (10-gage) sections. The elbows are forged from wrought-iron plate, with a smooth, uniform internal diameter and a reinforcing rib along both the outer and inner curvature of radius.

Duplex Car Unloader

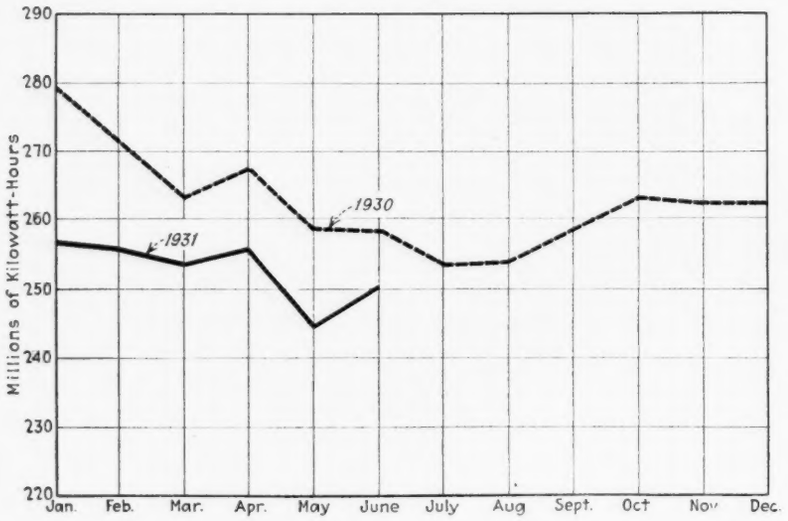
THE ONE-MAN car-unloading unit announced by the Barber-Greene Company, Aurora, Ill., is virtually a combination of a Model 52A car unloader with the boom of a standard flight conveyor. It has a capacity of one ton of coal per minute and is powered by a 10-hp. gasoline engine or a 7½ hp. electric motor. It is mounted on a narrow-gage industrial track which parallels the railroad track at the same height.

Model 52-A car unloader

For building up storage piles from trestles with a minimum of breakage the boom is equipped with a hoist and cable so that it may be lowered 25 deg. below horizontal and raised with the growth of the pile to 40 deg. above.

NEWS of the FIELD

Public Utility Power Output, 5 Per Cent Below Last Year, Shows Upward Trend



Average daily production of public utility power plants

ELECTRIC POWER production of public utility power plants in the United States during the first six months of this year totaled 45,778,000,000 kw.-hr., as compared with 48,344,000,000 kw.-hr. produced in the corresponding period of 1930, according to figures just released by the Geological Survey of the Department of the Interior. This amounts to a decrease of 5 per cent from last year's production and a drop of 3 per cent under the production level of the same period in 1929.

As shown by the chart, average daily production of electricity by public-utility plants in June, 1931, was 250,500,000 kw.-hr., 1.5 per cent more than the daily production for May and 1.7 per cent less than the daily output for April. The normal seasonal decrease in the daily demand for electricity from January to June is about 3 per cent; this year the decrease was about 2 per cent, which indicates that the seasonal effect on demand for electricity has been about normal this year, it is stated by the Geological Survey.

The production of electricity by the use of water power continues less than last year, indicating that the flow of power streams is still below normal owing to the continuation of drought conditions. During the first half of 1931 hydro-electric power amounted to 36 per cent of the total output, as compared with 38 per cent for the corresponding period last year.

Power production figures of the Geological Survey are based on the operation of all power plants producing 10,000 kw.-hr. or more per month, engaged in generating electricity for public use, including central stations, both commercial and municipal, electric railway plants, plants operated by steam railroads generating electricity for traction, Bureau of Reclamation plants, public works plants and that part of the output of manufacturing plants which is sold for public use.

Complete 50,000-Kw. Plant In Kirkstall, England

THE NEW Kirkstall power station of the Leeds Corporation in England, which has been constructed at a cost of $4,000,000, was opened last month by the Earl of Harewood, according to a report in *The Engineer*, of London.

At present the installation comprises two turbine-generator sets, each having a continuous output of 25,000 kw. at 0.7 power factor. The turbines are supplied with steam by three tri-drum boilers operating at 475 lb. pressure. Fired by pulverized coal, each boiler is capable of evaporating 160,000 lb. of water per hour under normal working conditions, or 184,000 lb. on overload. The boilers are equipped with economizers and air heaters. Steam is superheated to a temperature of 750 deg. F. Primary and secondary air fans and dust collectors are provided for each boiler.

Sales of Boilers, Stokers And Burners Increasing

A DECIDED INCREASE in the sales of boilers, mechanical stokers, pulverized-coal and oil burners was shown in June over those for May, according to reports submitted by manufacturers to the United States Bureau of the Census. New orders for boilers totaled 820 of 678,859 sq.ft. in June, compared with 658 of 603,401 in May. June sales of mechanical stokers amounted to 111 of 29,889 hp., compared with May totals of 80 of 23,646 hp. New orders for pulverizers in June aggregated 21 having a capacity of 66,160 lb. of coal, compared with 4 with a capacity of 4,300 lb. in May. Oil burner orders for June totaled 6,048, compared with 5,168 for May.

For the first six months of this year, new orders were placed for 3,911 boilers of 3,971,313 sq.ft., compared with orders for 6,452 boilers of 7,272,758 sq.ft. in the corresponding period of 1930. The following table gives the number, kind and square footage of all boilers sold during the first half of 1930 and 1931:

	1930		1931	
Kind	No.	Sq.Ft.	No.	Sq.Ft.
Stationary:				
Water tube	611	3,229,444	362	1,639,352
Horizontal return tubular	479	660,093	255	318,070
Vertical fire tube	643	204,139	330	87,955
Locomotive (not railway)	107	91,603	59	54,969
Steel heating	3,554	1,607,912	2,361	1,085,834
Oil country	583	670,345	245	275,241
Self contained portable	262	183,451	145	92,729
Miscellaneous	81	50,962	36	21,111
Total	6,320	6,697,949	3,793	3,575,261
Marine:				
Water tube	86	542,002	63	362,974
Pipe	2	2,236	4	5,240
Scotch	37	26,643	41	18,168
Miscellaneous	7	3,928	10	9,670
Total	132	547,809	118	396,052

Sales of mechanical stokers in the first six months of 1931 totaled 470 stokers of 130,002 hp., compared with 570 stokers of 183,911 hp. in the first half of last year. Of those sold this year,

250 were for installation under water-tube boilers of 953,960 sq.ft. and 220 were for fire-tube boilers of 346,060 square feet.

Orders for pulverizers for boiler installations in the first half of this year aggregated 72 pulverizers with a total capacity of 521,910 lb. of coal per hour contract. Of these 7 having a combined capacity of 220,000 lb. were for use in the storage system to fire water-tube boilers; 46 with a total capacity of 279,110 lb. were for use in the unit system to fire water-tube boilers; and 19 with a capacity of 22,800 lb. were for use in the unit system with fire-tube boilers. Comparable figures for the first six months of 1930 are not available.

The total number of new orders for oil burners placed in the first six months of 1931 were 28,797, compared with 38,802 in the corresponding period last year.

Program of Stevens-Columbia Conference on Economics

ANNOUNCEMENT has just been made of the program for economic conference for engineers, which will be held under the joint auspices of the alumni of Stevens Institute of Technology and Columbia University Engineering School at the Stevens Engineering Camp from Aug. 29 to Sept. 7 inclusive. During the conference lectures and seminars will be held in the mornings and round-table discussions in the evenings, leaving the afternoons free for recreation.

The first seminar, conducted by Ralph H. Richards on "Principles and Practices of Corporation Finance," will take up forms of business organization, instruments of finance, financial operating policy, earnings and dividends policies, marketing of securities and reorganization procedure. William D. Ennis and George W. Barnwell will conduct the second seminar dealing with "The Engineering Approach to Corporation Finance," which will cover the growth of money from a fixed deposit or from periodical payments, capital returns on bonds and stocks, depreciation as a factor in cost and in value, analysis of statements and offerings of securities and the working out of a reorganization program.

Round-table discussions in the evenings will be devoted to a study of the depression, touching on statistical indicators, conditions in other countries, explanations of the depression, emergency measures, stabilization, unemployment insurance and constructive planning. Dr. Harvey N. Davis, president of Stevens, will preside at these discussions and the speakers include Dean Donham of the Harvard School of Business Administration, S. L. Andrew of the American Telephone Company, W. H. Rastall of the Department of Commerce, William T. Foster and other leading economists and business men.

MEMORIAL TO OTTO AND LANGEN

Unveiling the memorial to Otto and Langen, inventors of the gas engine, at the recent 75th anniversary celebration of the Verein Deutscher Ingenieure. Erected at Köln-Deutz where Otto and Langen founded the famous "Gasmotorenfabrik Deutz," the memorial consists of one of their original atmospheric gas engines mounted on a stone column. It was donated by the Siemens-Ring Stiftung

▼ ▼ ▼

Discuss Flow Conditions Of Susquehanna River

ON AUG. 3, a conference was held at Safe Harbor, Pa., by an important group of interests to discuss the flow conditions of the Susquehanna. The meeting was called at the invitation of the Pennsylvania Water & Power Compan and the Safe Harbor Water Power Corporation.

Among those attending were representatives from the United States Engineers, Geological Survey, Pennsylvania Department of Forest and Water, Pennsylvania Power & Light Company, Susquehanna Electric Compan, W. S. Barstow & Company, Pennsylvania Water & Power Company and the Safe Harbor Water Power Corporation.

The conference discussed the early efforts and record of stream gauging, the present work being done by the various orginizations interested in the flow of the Susquehanna, and the technical aspects of past and future records in the interest of greater uniformity and consistency. Two of the test methods, as described by N.E.L.A. publication No. 115, were gone into quite carefully and Mr. Parsons of the United States Engineers described some practical applications that had been made of these methods. The greater knowledge in comparison of stream records is apparently leading to the impression that past records must not be broadly accepted on their face value, but require a further interpretation and analysis if their greatest value is to be uncovered. The value of flow records from a financial viewpoint was emphasized as a means of guiding the operation of equalization reserves, and also as the basis for cyclic analysis.

Canada Annuls License Of Beauharnois Company

AS A RESULT of the recent Parliamentary investigation into the affairs of the Beauharnois Power Corporation, the Dominion Government has voted to annul the order in council which approved the company's large power development at Beauharnois, Quebec, Premier R. B. Bennett has announced.

He said four possibilities were now open in respect to the management of the great development. The present management might be able to secure financial backing to enable it to continue; the property could be taken over by the Province of Quebec; the Dominion might take over the project and

operate it as a public utility, or the company might be reorganized completely under new conditions prescribed by act of parliament so as to insure the continued progress of the work of the enterprise. Premier Bennett intimated that he preferred the last possibility.

The order in council referred to granted the Beauharnois interests a flow of 40,000 ft. a minute from the St. Lawrence River for power generation. It was being canceled, it was explained, because of the circumstances under which it was obtained and because the interests had acted in "defiance of Canada."

Committee to Revise Carbon Brush Standards

AT A MEETING of the standing committee in charge of Simplified Practice Recommendation R56-28 on Carbon Brushes and Brush Shunts, held recently at the National Carbon Company offices in Cleveland, Ohio, it was voted to reaffirm all items in the present recommendation with the exception of brush dimensions. In the opinion of the members, a further simplification of dimensions could be agreed upon by all parties concerned within the next few months. The committee therefore voted to hold in abeyance the publication of a revised recommendation until the new list, showing a smaller number of brush dimensions, had been approved by manufacturers of brushes, motors and generators. It is expected that this will be done within the next three months, and will result in largely reducing the number of stock items catalogued by all manufacturers.

The committee further voted to include in the revised recommendation certain additional definitions, together with a table showing the nomenclature recently adopted by the brush manufacturers to indicate the various standard types of shunt connections. It was hoped that a further reduction could be made in the number of shunt lengths. Some of the manufacturers have already reduced the number of lengths from six to three.

Illinois Utilities Order Largest Transformers

TRANSFORMERS that will exceed by thousands of pounds the largest machines ever built at the Pittsfield, Mass., works of the General Electric Company have been ordered by the Commonwealth Edison Company of Chicago and the Super Power Company of Illinois as part of an order for more than $1,000,000 worth of equipment. Delivery of the twenty transformers involved is expected early in 1932.

So large are eight of the units, it is stated, that special drop-frame transformer cars must be built to ship them.

COMING CONVENTIONS

American Society of Mechanical Engineers. Regional meeting in Kansas City, Mo., Sept. 7-9. Annual meeting in New York City, Nov. 30-Dec. 4. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Association of Engineers. Seventeenth annual convention at Huntington, W. Va., Sept., 28-30. Secretary, M. E. McIver, Willoughby Tower, Chicago, Ill.

American Institute of Electrical Engineers. District meeting at Lake Tahoe, Calif., Aug. 25-28. District meeting at Kansas City, Mo., Oct. 22-24. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Welding Society. Fall meeting at the Copley-Plaza Hotel, Boston, Mass., Sept. 21-25. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Edison Illuminating Companies. Forty-seventh annual meeting at The Greenbrier, White Sulphur Springs, W. Va., Sept. 21-25. Secretary, Preston S. Millar, 80th St. and East End Ave., New York City.

International Railway Fuel Association. Annual convention at the Hotel Sherman, Chicago, Ill., Sept. 15-16. Secretary, C. T. Winkless, Room 700, La Salle Street Station, Chicago, Ill.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago.

Southwest Power Conference and Show will be held in Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, George F. Klein, Chamber of Commerce, Kansas City, Mo.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

The transformers will be used on both ends of a new 220,000-volt transmission line extending about 100 miles from Powerton to the Crawford Avenue station of the Commonwealth Edison Company at Chicago. For the receiving end, there will be required four 67,500-kva. power transformers and four 50,000-kva. regulating transformers. The power units, the heaviest, will weigh 491,000 lb. each, filled with oil.

Physically they will rival other big units made at the Pittsfield works in recent years. They will be 30 ft. high overall, 27½ ft. long and 19½ ft. wide. In addition to these power units for the receiving station, there will be four regulating units, of 50,000-kva. output each, somewhat smaller in size and weighing 146,000 lb. each.

At the sending end of the line there will be four 60,000-kva. units, weighing 406,000 lb. each, and eight 30,000-kva. regulating transformers weighing 75,000 lb. each.

Personals

CAPTAIN WALTER M. MCFARLAND, manager of the marine department of the Babcock & Wilcox Company, will retire on Sept. 1 because of ill health, according to an announcement of C. W. Middleton, vice-president of the company. Widely known in the marine field, Captain McFarland was at one time principal assistant to Admiral GEORGE W. MELVILLE, engineer-in-chief of the United States Navy. He held the rank of chief engineer and in 1897 was a member of the board to reorganize the personnel of the Navy. He resigned from Naval service in 1899 to become vice-president of the Westinghouse Electric & Manufacturing Company, which position he held until April, 1910, when he became manager of the B. & W. marine department.

MARCEL GARSAUD, engineer member of the Federal Power Commission, left Washington, D. C., Aug. 5 on a tour of the country, to familiarize himself with a number of important projects under license. His itinerary calls for three days in Niagara Falls where he hopes to be able to speed up the work of examining the records of that company. His next stop will be at the Flathead project in Montana. He will inspect the site Z canyon on the Columbia River in Washington. His visit also will include trips to the Kettle Falls project of the Washington Water Power Company. He will confer with western representatives of the commission and with representatives of the power companies in Spokane and Seattle. He will visit other projects on the Columbia, Deschutes, Pit, Feather, Yuba, Mokelumne, San Joaquin, Kings and Kern rivers.

WILLIAM F. RABER has been elected president of the San Diego, (Calif.) Consolidated Gas & Electric Company, according to announcement of JOHN J. O'BRIEN, president of the Standard Gas & Electric Company. Mr. Raber has been vice-president and general manager of the San Diego company since 1924. The office of president has been held by ROBERT J. GRAF, first vice-president of the Standard Gas & Electric Company and Byllesby Engineering & Management Corporation.

LUKE ELLIS, formerly connected with the Pennsylvania Water & Power Company, and more recently chief engineer of the Public Service Commission of Maryland, has been appointed associate engineer in the Department of Public Works of the City of Baltimore. In this position he will have charge of the public service corporation work of the department.

THOMAS S. BURNS, formerly hydroelectric engineer with the Power Corporation of New York, has been appointed senior engineer in the United States service, with headquarters at Huntington, W. Va.

Business Notes

B. F. Sturtevant Company, Hyde Park, Boston, Mass., announces the following changes in sales personnel: Walter L. Hunken has been appointed manager of the company's Greensboro, N. C., office; Philip Cohen has been made acting manager of the Cleveland office; and E. A. Engdahl has been appointed manager of the Seattle office.

The Ric-wiL Company, Cleveland, Ohio, announces that it has recently purchased the Standard Underground Conduit Company, of Atlanta, Ga. All information relative to "Standard Underground Conduit" may now be obtain from the Ric-wil Company.

American Valve Company, Coxsackie, N. Y., has been purchased by the principals of the Hudson Brass Works, Inc., Brooklyn, N. Y., it is announced. Executive offices and a general warehouse for the combination have been established at 16 Nassau St., Brooklyn. Theodore Guterman, president, is in charge of the Brooklyn works, while Samuel Gade, vice-president, is supervising operations at the plant in Coxsackie.

Sullivan Machinery Company, Chicago, Ill., announces the removal of its New England sales office from 45 Milk St. to 100-102 Brookline Ave., Boston Mass., where ample warehouse facilities will be provided for carrying a full line of equipment and parts. Edwin T. Hall is manager of the New England office.

Merger of the Charles H. Tenney & Company public utility holdings with those of the New England Power Association, which was reported in *Power* for July 7, has now been completed, according to Frank D. Comerford of the Association. A large percentage of the voting trust shareholders of the North Boston Lighting properties have exchanged their certificates for shares of Massachusetts Power & Light Associates, he stated. The time for effecting the remaining exchanges has been extended to Aug. 22.

Ellison Draft Gage Company, Chicago, Ill., announces the appointment of the Smiley Equipment Company, 102 Carmen's Building, Kansas City, Mo., as exclusive representative in eastern Kansas and western Missouri. The Ellison company has also appointed the Power Equipment Company, 5473 Delmar Blvd., St. Louis, Mo., as exclusive representative in the eastern Missouri territory.

Republic Steel Corporation, Youngstown, Ohio, announces the appointment of L. S. Hamaker as manager of sales promotion. Mr. Hamaker was formerly advertising manager of the company. He will assume his new duties immediately, making his headquarters at Youngstown.

How's Business?

Earnings reports for the second quarter are not discouraging. European difficulties seem less menacing. Germany is calm; London is fortified with our credit. These are the two cheerful things to be said of the most sluggish week of a sluggish summer. The pulse of August, always listless, drops to a new low rhythm; as recorded by our index. Automobile plants close down; building is curtailed sharply, foreshadowing dull days for steel makers. Cotton, wheat and copper prices move slowly downward in lackadaisical trading. Efforts to dispose of surplus stores abroad are commended by statesmen and economists, criticized by some sectional politicians. Security markets were unexciting. Declines in car loadings and bank debits also reflect the summer inertia.—*The Business Week*, Aug. 12.

Trade Catalogs

Pumps—Bulletin No. 316, recently issued by the Byron Jackson Company, Berkeley, Calif., describes and illustrates the company's deepwell turbine pumps. Information is given on the design and construction features of these pumps; hydraulic formulas, conversion factors and charts are included, as well as many photographs of actual installations.

Blowers and Compressors—Ingersoll-Rand Company, 11 Broadway, New York City, has just issued Bulletin No. 3132, a 44-page booklet describing and illustrating the company's line of turbine-blowers and turbine-compressors. Information is given on the construction and operation of single-stage and multi-stage blowers for discharge pressures of 1 to 40 lb. and capacities of 3,000 to 100,000 cu.ft. per minute; the turbine-compressors for discharge pressures up to 110 lb. and capacities of 8,000 to 10,000 cu.ft. per minute. In addition to photographs of blower parts and complete units, the bulletin contains many sectional drawings and charts.

Protective Coatings—A graphic picture of the appearance of "Apexior" coating for boilers, before and after a service run, together with an explanation of how it protects internal boiler surfaces, is given in Bulletin No. 1270 just issued by The Dampney Company of America, Hyde Park, Boston, Mass.

Valves—The new Ludlow multivalve for steam, air, gas, water, oil and viscous liquids is described and illustrated in a recent bulletin (No. 101) issued by the Ludlow Valve Manufacturing Company, Troy, N. Y.

Refractories—The properties and uses of "P. B. Sillimanite" refractories for boiler and process furnaces are discussed in a new booklet of the Charles Taylor Sons Company, Cincinnati, Ohio. A description of pyrometer protection tubes and glass refractories is also given in the booklet.

Regulators—A new loose-leaf catalog covering control systems for combustion, furnace draft, valves and process equipment has recently been issued by the Shallcross Control Systems Company, 1195-99 Thirtieth St., Milwaukee, Wis. Blueprint specifications of individual installations are included in the catalog together with many illustrations.

▼

Fuel Prices

FUEL OIL

Boston—Aug. 3, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.9c. per gal.; 28@32 deg., 4.85c. per gal.

New York—Aug. 6, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 3.75c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 4.75c. per gal.

Philadelphia—Aug. 1, No. 3, industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl.

Pittsburgh—Aug. 4, f.o.b. local refinery, fuel oil, 30@34 deg., 2.375c.@2.625c. per gal.; 36@40 deg., 2.375c.@2.625c. per gal.

Cincinnati — Aug. 4, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—Aug. 1, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 22.5c. per bbl.; 22@24 deg., 25c. per bbl.; 24@26 deg., 27.5c. per bbl.; 26@28 deg., 32.5 per bbl.; 28@30 deg., 37.5 per bbl.

St. Louis — Aug. 4, tank-car lots, f.o.b. St. Louis, 24@26 deg., 99.5c. per bbl., or 42 gal.; 26@28 deg., $1.045 per bbl.; 28@30 deg., $1.12 per bbl.; 30@32 deg., $1.17 per bbl.; 32@36 deg., gas oil, 2.401c. per gal.; 38@40 deg., distillate, 2.901c. per gal.

Dallas—Aug. 1, f.o.b. local refinery 24@26 deg., 65c. per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York	$1.60 @ $1.80
Pool 10, h. gr. low-vol.	New York	1.50 @ 1.60
Pool 11, low-vol.	New York	1.35 @ 1.45
Smokeless, mine-run	Chicago	1.50 @ 1.75
Smokeless, slack	Chicago	.50 @ 1.10
Harlan, Ky., slack	Chicago	.85 @ 1.10
Franklin, Ill., mine-run	Chicago	2.15
Franklin, Ill., screen	Chicago	1.10 @ 1.60
Ind. 5th Vein, m.-r.	Chicago	1.20 @ 1.75
Standard Ill., mine-run	St. Louis	1.25 @ 1.40
W. Ky., mine-run	Louisville	.85 @ 1.00
W. Ky., slack	Louisville	.60 @ .75
Pittsburgh, mine-run	Pittsburgh	1.25 @ 1.45
Smokeless, mine-run	Cincinnati	1.60 @ 1.75
Smokeless, slack	Cincinnati	.75 @ 1.10
Kanawha, mine-run	Cincinnati	.90 @ 1.25
Kanawha, nut-slack	Cincinnati	.50 @ .75
Anthracite (Net Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York	$3.25
Barley	New York	.90 @ 1.40

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Benton—State Hospital for Nervous Diseases, c/o Arkansas Construction Commission, is having tentative plans made for a pumping station with complete pumping equipment on Saline River, to furnish a water supply to new State Hospital to Lund Engineering Co., Southern Bldg., Little Rock, is engineer.

Calif., Hilmar—Turlock Irrigation District, A. M. Sorensen, Secy., Turlock, will build a sub-station to include three 1,000 kva. transformers, here. Private plans. Work will be done by day labor.

Calif., San Diego—Public Works Officer, 11th Naval District, will receive bids until Aug. 18 for the construction of a refrigeration plant at Naval Operating Base Air Station, Spec. 6562.

Calif., Vernon—City, T. J. Furlong, Clk., awarded contract for furnishing and installing generating equipment in municipal power plant to Hooven-Owens-Rentschler Co., Hamilton, O. $1,600,000.

Ind., Hobart — School Commissioners, will soon award contract for the construction of a central heating plant including boilers and heating equipment at East 4th St. Estimated cost $40,000. Wainwright & Wilkins, Hammond, are engineers.

Minn., Minneapolis — Archer-Daniels-Midland Co., 600 Roanoke Bldg., linseed oil manufacturers, awarded contract for addition to grain storage elevator, 7,000,000 bu. capacity to include 126 cylindrical tanks, each 152 ft. high at 29th Ave. S. E., to McKenzie-Hague Co., 422 Corn Exchange Bldg. Estimated cost $750,000.

Mo., St. Louis—Midwest Industrial Development Co., subsidiary of Illinois Terminal, R.R. A. P. Titus, V. Pres., 1221 Locust St., is having plans prepared for an 11 story passenger station and office building at 12th St. and Washington Ave. Estimated cost $1,500,000. Mauran, Russell & Crowell, Chemical Bldg., are architects.

Nev., Battle Mountain—Bd. of County Commissioners, of Lander Co., Austin, will receive bids until Aug. 17 for drilling and equipping well with pumping plant, steel water tank, water mains, etc. H. R. Lemarie is engineer.

N. H., Concord—New Hampshire State Hospital, W. A. Stone, Purch. Agt., State House, is receiving bids for the construction of a power plant. Estimated cost $40,000. R. D. Kimball Co., 6 Beacon St., Boston, is architect.

N. Y., Chateaugay—New York State Electric & Gas Corp., Ithaca, has received permission from Public Service Commission to construct an electric plant and exercise a franchise for furnishing of electricity in village of Chateaugay, Franklin County.

N. Y., Lake Placid — City voted $150,000 bonds for the construction of an indoor ice rink and arena for winter olympic games.

Ohio—Dept. of Public Welfare, Columbus, plans an election to vote $7,500,000 bonds for rehabilitation and extensions to various state institutions to include cold storage plant, new cottage, etc., at Institution for Feeble Minded, Columbus, $325,000; additional unit in power system, industrial building, administration building, cottages, etc., at Hawthornden Farm, Cleveland State Hospital, Cleveland, $800,000; cold storage plant, boilers and stokers, cottages, etc., at Dayton State Hospital, Dayton, $530,000; boilers, stokers, industrial building, cottage addition, etc., at Massillon State Hospital, Massillon, $200,000; engines, generators, cottage, etc., at Toledo State Hospital, Toledo, $380,000; power plant equipment, cottage and equipment, dairy barn and equipment at Ohio State Hospital for Epileptics, Gallipolis, $360,000; cottages, cold storage plant, storerooms, etc., at Institution for Feeble Minded, Apple Creek, $1,450,000; power plant and equipment, etc., at Ohio Reformatory for Women, Maryville, $60,000.

O., Cincinnati—Cincinnati Times Star, 6th and Walnut Sts., awarded contract for an 18 story newspaper building at 8th St. and Broadway to Ferro Concrete Co., 3rd and Elm Sts. Estimated cost $1,800,000.

Okla., Supply—Board of Affairs, Capitol, Oklahoma City, awarded contract for the construction of a 42 x 100 ft. power house at Western Oklahoma Hospital here, to C. M. Dunning Construction Co., 420 North Hudson St., Oklahoma City. Estimated cost $150,000.

Pa., Coraopolis—Canfield Oil Co., L. Carruth, Pres., 620 4th Ave., awarded contract for a 2 story, 16 x 60 ft. refrigeration plant on 4th Ave. to J. Wasum, 1138 Vance Ave., Coraopolis. Estimated cost $40,000.

Pa., Philadelphia—Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans the construction of a 6 story hospital at Pattison and 16th Sts. Estimated cost $3,200,000. Karcher & Smith, 1520 Locust St., are architects.

Tex., Dallas—City, c/o E. Goforth, Secy., will receive bids about Aug. 15 for the construction of a sewage disposal plant including 44 x 74 ft. pump and blower station, 20 x 20 ft. pumping station, six air compressors, etc. Estimated cost $1,700,000. Hawley, Freese & Nichols, Capps Bldg., Fort Worth, are engineers.

Tex., Houston—Southern Pacific Co., 65 Market St., San Francisco, Calif., had plans prepared for the construction of a passenger station here. Estimated cost $5,000,000. G. W. Boschke, San Francisco, is chief engineer.

Tex., Longview—Lucey Petroleum Co., J. F. Lucey, awarded contract for the construction of a 4½ mi. pipe line and a 5 stage pumping station to Gregg Construction Co. Inc., Longview. $35,000.

Vt., Bennington—State of Vermont, G. H. T. Johnson, Montpelier, awarded contract for the construction of a central heating plant at Soldiers Home here, to M. J. Burrington, Jr., 495 Main St., Bennington. Estimated total cost $50,000. Bids opened July 7 for two boilers and radial chimney.

Wis., Racine—City awarded contract for the construction of a lift suction well and pumping station, to P. Bondgard Construction Co., Racine, $40,500.

Ont., Toronto — City awarded contract for supply and installation of eight water tube steam boilers for John St. waterworks pumping station to John Inglis Co. Ltd., 14 Strachan Ave., Toronto. $93,000.

Ont., Toronto—Ontario Hydro Electric Power Commission, 190 University Ave., plans the construction of a 22 story addition to present building. Estimated cost $2,000,000.

Ont., Toronto—Toronto Hydro Electric Commission, 225 Yonge St., is having plans prepared for the construction of an 8 or 10 story building at College and Yonge Sts. Estimated cost $1,000,000.

T. H., Fort Shafter—Department Quartermaster, Fort Shafter, will receive bids until Aug. 25 for additions and extensions to sewage system including construction of sewerage pumping plant, etc.

Equipment Wanted

Power Rectifier Equipment — Philadelphia, Pa.—Dept. of City Transit, C. E. Myers, Dir., City Hall Annex, will receive bids until Aug. 18 for Mercury-arc power rectifier equipment for sub-station No. 6, Broda St. Subway (2 units) Cont. 219.

Pump—Beverly Hills, Calif.—City, B. J. Firminger, Clk., will receive bids until Aug. 25 for a booster pump for water department.

Pump—Ellensburg, Washington—Bureau of Reclamation will receive bids until Aug. 25 for a Wippel pump, gravity and turbine laterals, etc., in connection with earthwork and structures on North Bank Canal lateral system, Kittitas Division, Yakima project here.

Pumps—Colchester, Ill.—City will soon receive bids for two centrifugal pumps, etc., for proposed waterworks improvements.

Switching Equipment—Glendale, Calif.—City Council will receive bids until Aug. 20 for equipment for outdoor switching station for Public Service Department.

Switchgear and Auxiliary Apparatus — Petoria, South Africa—City Council, will receive bids until Sept. 18 for switchgear and auxiliary apparatus in connection with installation of two 12,500 kw. 3 ph. turbo-alternators.

Industrial Projects

Calif., Los Angeles—Crown Willamette Paper Co., a division of Zellerback Paper Co., 220 South Los Angeles St., awarded contract for the construction of a 193 x 315 ft. converting plant, warehouse and office for the manufacture of newly developed wrappers for citrus fruits that will protect fruit from moisture and harmful atmosphere, at 12th and Evergreen Sts., to Austin Co. of California, 777 East Washington St. Estimated cost $300,000.

La., New Orleans—A. M. Lockett & Co. Ltd., Q. & C. Bldg., (pipe line engineers), awarded contract for a group of factory buildings to The Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $100,000.

Mass., Canton—Plymouth Rubber Co., Inc., Revere St., awarded contract for addition and alterations to factory unit No. 9 to Platt Construction Co., 711 Main St., Waltham. Estimated cost $40,000.

Mass., Willimansett—Palmer Steel Co., 1694 Main St., Springfield, is receiving bids for the construction of a 1 story, 80 x 180 and 60 x 360 ft. additions to factory. Estimated cost to exceed $40,000. Private plans.

Mich., Detroit—Mechanical Handling Systems Inc., 3454 Denton St., manufacturers of conveyors, awarded contract for the construction of a 1 story factory to Austin Co., 16112 Euclid Ave., Cleveland, O. Estimated cost $100,000.

N. J., East Rutherford—East Rutherford Syringe Co., 75 Mozart St., will receive bids about April, 1932, for a 2 story, 30 x 70 ft. syringe factory. Estimated cost $40,000. J. T. Camlet, 26 Piaget Ave., Clifton, is architect.

N. J., Newark—Weldon Roberts Rubber Co., 18 Oliver St., awarded contract for a 2 story addition to factory at 361-65 6th Ave., to Lorenz-Haase, 361 6th Ave. Estimated cost $40,000.

N. J., Trenton—C. V. Hill & Co., Pennington Ave., plan the construction of a porcelain plant. Estimated cost $50,000. Architect not selected.

O., Cincinnati—Schell Leather Goods Co., 1015 Race St., awarded contract for a 2 story, 100 x 100 ft. factory on Central Parkway to Parkway Construction Co., 300 Provident Bank, $40,000.

O., Cleveland—Smolensky Valve & Fitting Co., M. Smolensky, Pres., 1931 West 47th St., is having plans prepared for a 3 story, 40 x 100 ft. factory and warehouse on Broadway. Estimated cost $40,000. Private plans.

O., East Liverpool—Patterson Foundry & Machine Co., plans the construction of a factory unit to house new power plant, including generating units to be used by three factories on St. George St. Estimated cost $75,000. Private plans.

Pa., Aspinwall—National Torch Tip Machine Co., 125 Washington Blvd., Pittsburgh, awarded contract for a 1 story, 50 x 75 and 12 x 17 ft. factory and office on Freeport Rd., here, to Frank K. West & Co., 1235 Washington Blvd., Pittsburgh. Estimated cost $40,000.

Tex., Longview—Danciger Oil & Refining Co., Pampa, Tex., awarded contract for the construction of a crude oil refinery, 10,000 bbl. capacity, near here, to Southwestern Engineering Co., Longview. Estimated cost $200,000.

Tex., Seymour—J. Harris and J. R. Fowler, will build an oil refinery, 300 bbl. capacity. Estimated cost $50,000. Private plans. Work will be done by day labor.

W. Va., Newell—Edwin M. Knowles China Co., plans the construction of an electric decorating tunnel kiln, 20 x 60 ft., to be installed in semi-porcelain factory in western pottery district. Estimated cost $75,000.

Ont., Spragge—J. J. McFadden Lumber Co., will build a sawmill destroyed by fire. Estimated cost $200,000. Work will be done by day labor. Private plans.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

IN the downward movement of prices, declines became effective during July, in silica brick, friction and rubber tape, cold-finished steel, babbitt metal and solder. There were, however, a few notable exceptions, chief among which was an advance in prices for armored cable at New York. Cement prices also developed definitely firmer tendencies in several cities throughout the country. Aside from the materials mentioned, power plant supplies remained without change in price during the month.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket, net, per ft		$0.51
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less		70%
	Air—Best Grade, Net	
¾-in., per ft	3-ply $0.271	4 ply $0.337
	Steam—Discounts from List	
First grade 59%	Second grade 60–5%	Third grade 60–10–10%

RUBBER BELTING—List price, 6-in., 6 ply, $1.83 per lin.ft. The following discounts from New York warehouse list apply to rubber transmission belting:

Best grade 60–10–10% Second grade 70–10%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses in quantities of about ½ doz. rolls:

Grade	Discount from list
Medium	40-5%
Heavy	30-10%

RAWHIDE LACING
- Cut lacing, best quality, 45%; 2nd quality, 60%.
- Lace leather sides, best, 15-17 sq.ft., 45c. per sq.ft.; 2nd, 40c., net.
- Giant or Indian tanned cut lacing, 30-10%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		40 %
Asbestos, air cell, for low-pressure heating and return lines	4-ply	65 %
	3-ply	67½%
	2-ply	70 %

PORTLAND CEMENT—New York, $1.85 per bbl., without including charge for four cloth bags, delivered by truck to site of job. Bag charge 10c. each, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.10 per 100 lb. in lots of 401 to 999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	7.00@11.00	13.00	13.00
Colored	5.50@9.00	9.00	9.00

WIPING CLOTHS—Prices per pound in lots of about six bales (600 lb.), for colored wipers, as follows:

New York	$0.12
Cleveland	.08
Chicago	.09

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Minneapolis	Chicago
Per pound	$0.092	$0.107	$0.098

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.25	$14.75
White	13.25	13.25

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, ⅞-in. diameter and smaller, list less 65% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, full kegs, per 100 lb.:

New York	$4.00
Chicago	4.00
Pittsburgh mill	2.75

Broken kegs, about 50c. higher.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome ore, ground, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome ore, ground, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Chrome ore, crude, 40@50%, Cr_2O_3	per net ton	20.00@22.50
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa	per M	40.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	32@35
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	32@35
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	32@35

BABBITT METAL—Delivered in case-lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

Genuine, highest grade	44.00
Commercial genuine, intermediate grade	34.25
Anti-friction metal, general service	28.50
Solder, bar	19.12½

COLD-FINISHED STEEL—Warehouse prices on shafting and screw stock, per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.10	$3.10
Flat or square	3.90	3.60	3.60

BOILER FITTINGS—Discounts from list at New York warehouse:

Copper ferrules	70%
Flanges	50%
Stay bolts	60%
Patch bolts	20%
Fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list, are for large mill-lots at Pittsburgh mill:

BUTT WELD

	Steel			Iron	
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	64%	52½%	1 and 1¼	31%	15%
LAP WELD					
2	57%	45½%	¾	23%	9%
2½ to 6	61%	49½%	2½ to 3½	28%	13%
7 and 8	58%	45½%	4 to 6	30%	17%
9 and 10	56%	43½%	7 and 8	29%	16%
11 and 12	55%	42½%	9 to 12	26%	11%
BUTT WELD, EXTRA STRONG, PLAIN ENDS					
1 to 1½	62%	51½%	1 to 2	34%	18%
2 to 3	63%	52½%			
LAP WELD, EXTRA STRONG, PLAIN ENDS					
2	55%	44½%	2	29%	13%
2½ to 4	59%	48½%	2½ to 4	34%	20%
4½ to 6	58%	47½%	4½ to 6	33%	19%
7 and 8	54%	41½%	7 and 8	31%	17%
9 and 10	47%	34½%	9 to 12	21%	8%
11 and 12	46%	33½%			

BOILER TUBES—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U. S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

Size, Inches*	B.W.G.	Toncan Seamless Iron	Knobbled Charcoal Iron	Seamless Steel	Lapwelded Steel
1	13	$34.00	.....	$18.00	.....
1¼	13	37.75	.....	20.25	.....
1½	13	38.00	$38.00	19.25	.....
1¾	13	30.00	30.00	22.00	.....
2	13	26.25	26.25	20.25	$19.00
2¼	13	34.50	34.50	23.00	25.00
2½	12	34.00	34.00	26.00	24.25
2¾	12	40.50	40.50	28.50	27.50
3	12	42.50	42.50	27.00	25.50
3¼	11	50.25	50.25	30.75	28.75
3½	11	54.50	54.50	33.25	31.50
4	10	67.00	67.00	40.00	38.00

These prices are based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller..$0.05 per cut
2¼ and 2½ in.....06 per cut
3-in.....$0.09 per cut
3½ to 4 in.....10 per cut

*External diameter.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$23.50	$33.00	$55.00	$75.00
No. 12 solid....	33.00	44.00	66.00	91.00
No. 10 solid....	45.00	57.00	82.00	105.00
No. 8 stranded..	73.00	92.00	115.00	155.00
No. 6 stranded..	105.00	129.00	155.00	220.00

Coils to 1000 ft., +10%; less than coil lots, +20%.

CONDUIT—Rigid iron, price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra. Delivered from New York warehouse. Discount of 5 per cent for payment in 10 days; 30 days net:

Size, Inches	GALVANIZED Conduit	GALVANIZED Couplings	GALVANIZED Elbows	BLACK Conduit	BLACK Couplings	BLACK Elbows
¼	$52.15	$3.15	$7.55	$47.31	$2.86	$6.47
⅜	52.75	3.78	7.60	47.91	3.44	6.52
½	53.93	4.42	7.72	49.09	4.02	6.64
¾	68.61	6.34	10.17	62.05	5.78	8.75
1	98.17	8.28	15.19	88.49	7.54	13.09
1¼	132.83	11.67	20.88	119.72	10.71	18.33
1½	158.82	14.46	27.94	143.14	13.26	24.52
2	213.68	19.35	50.82	192.60	17.77	44.55
2½	337.85	27.65	84.15	304.50	25.37	73.89
3	441.80	41.44	216.97	398.19	38.02	189.61
3½	557.58	55.61	474.82	505.14	51.05	414.40
4	681.33	69.30	549.07	619.19	63.60	479.25
4½	793.78	103.32	827.42	721.41	94.76	721.70
5	925.10	114.02	1150.87	840.74	104.61	1004.11
6	1200.61	164.80	1435.97	1090.67	151.12	1253.57

CONDUIT BODIES AND FITTINGS—Black or galvanized:

	Less Than $15 List	$15 List to $100	$100 List and Over
Standard package	15%	20%	28%
Less than standard package	10%	15%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$14.00
No. 16 cotton reinforced heavy		17.50
No. 18 cotton reinforced light		11.50
No. 16 cotton reinforced light		14.00
No. 18 cotton Canvasite cord		12.50
No. 16 cotton Canvasite cord		13.60
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$54.00	*59.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	82.00	*89.50

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount With Contract—Fuses:	
Broken cartons	5%
Unbroken cartons	20%
Ten unbroken cartons	36%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	36%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500), per 100	$2.50
0-30 ampere, less than standard package, per 100	2.75

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	....	.....
60	A 21	.20	...	....	.....
100	A 23	.35	...	....	.....

Carton quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.05

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$4.40	$6.40	$7.40	$12.60
12	6.40	7.75	9.20	16.00
10	8.50	10.20	11.70	21.00
8	12.20	14.30	16 75	29.00
6	.....	.....	24.60	.....
4	.....	.....	33.40	.....
2	.....	.....	46.00	.....
1	.....	.....	66.00	.....
0	.....	.....	78.00	.....
00	.....	.....	91 00	.....
000	.....	.....	106.00	.....
0000	.....	.....	131.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In or Pendant Cap Key	Keyless	Pull	¾ In. Cap Key	Keyless	Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 25c. per lb.; in 100 lb. lots, 24c. per lb.
Rubber tape, ¾ in., in less than 100 lb., 26c. per lb.; in 100 lb. lots, 24c. per lb.
Wire solder, in less than 100 lb., 24c. per lb.; in 100 lb. lots, 20c. per lb.
Soldering paste, 2 oz. cans ..... $1.10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.:

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:	
Standard package	50%
Less than standard package	45%